This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com



Digitized by Google



Francis William Stubbs.

Digitized by Google

Digitized by Google

23174 c. 42

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

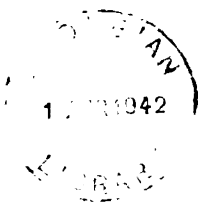
Digitized by Google

MADRAS

ARTILLERY RECORDS

VOLUME. 7.

Digitized by Google



Digitized by Google

Artillery

Fig 16

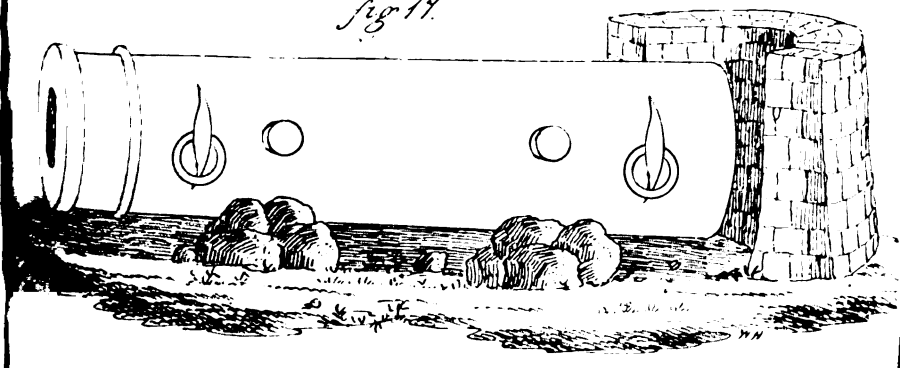


Agra Gun

	ft	in	lb		ft	in	lb
Length of Gun	14.	2.	0	Diam^{r} of Bore	1.	11	0
—.— Bore	8.	8.	0	—.—.— Chamber	.	10.	0
—.— Chamber	4.	4.	0	—.— Muzzle	3.	10.	0

Weight of Gun 4 3 5 tons
Weight of Shot 1500 lbs

Fig 17.



Beder Gun

	ft	in	lb		ft	in	lb
Length of Gun	14.	9.	0	Diam^{r} of Muzzle	3.	7.	6
Diam^{r} of Bore	1.	7.	4	—.— Breech	3	10.	8

Weight of Shot 96 lbs

Digitized by Google

Digitized by Google

MISCELLANEOUS.

Digitized by Google

Digitized by Google

MISCELLANEOUS.

Memorandum of Ordnance found on the works of the Fort of Kurnool on the 16th December 1815. Vide fig. 1.

Nature of Ordnance.	Number.	Weight of Iron Shot.		Diameter of Bore.		Length of Gun.		Remarks.
		lbs.	oz.	in.	pts.	ft.	in.	
Malabar Iron Gun..	1	187	0	11	0	18	0	On Blocks.
" " "	1	155	0	10	5	15	0	do.
" " "	1	140	0	10	0	7	0	do.
" " "	1	102	8	9	0	13	0	On Truck Carriage.
" " "	1	72	0	8	0	12	0	On Blocks.
" " "	1	48	0	7	0	12	0	do.
" " "	1	42	0	0	0	10	0	Dismounted useless.
" " "	1	24	0	0	0	11	0	On Carriage.
" " "	1	24	0	0	0	7	6	On Blocks.
" " "	1	24	0	0	0	10	0	On Carriage.
" " "	1	24	0	0	0	8	6	do.
" " "	1	18	0	0	0	8	0	On Truck Carriage.
" " "	1	18	0	0	0	8	0	Dismounted.
" " "	1	18	0	0	0	9	0	On Carriage.
" " "	1	14	0	0	0	10	6	do.
" " "	1	12	0	0	0	8	0	On Truck Carriage.
" " "	1	12	0	0	0	6	9	Dismounted.
" " "	2	9	0	0	0	5	0	On Blocks.
" " "	1	9	0	0	0	6	9	On Truck Carriage.
" " "	1	8	0	0	0	6	0	On Carriage.
" " "	1	6	0	0	0	6	10½	On Blocks.
" " "	1	4	0	0	0	4	11	On Carriage.
" " "	1	4	0	0	0	6	0	On Blocks.
" " "	1	4	0	0	0	8	0	do.
" " "	2	2	0	0	0	8	0	do.
" " "	1	9	0	0	0	9	6	On Carriage.
" " "	1	1	0	0	0	4	6	do.
Iron Swivels..	1	3	0	0	0	4	0	On Blocks.
" "	31	1	0	0	0	3	0	do.
" Gingalls..	2	0	8	0	0	9	0	

Digitized by Google

Nature of Ordnance.	Number.	Weight of Iron Shot.		Diameter of Bore.		Length of Gun.		Remarks.
		lbs.	oz.	in.	pts.	ft.	in.	
Malabar Mortars Iron . .	1	0	0	14	0	0	0	Fixed in the ground.
„ „ „	1	0	0	9	0	0	0	do.
„ „ „	2	0	0	5	0	0	0	do.
„ „ „	4	0	0	3	0	0	0	do.
Brass Guns. .	1	9	0	0	0	7	0	On Carrriage.
„ „	2	4	0	0	0	6	0	do.
„ „	1	3	0	0	0	5	6	do.
„ „	1	3	0	0	0	4	0	do.
„ „	2	2	0	0	0	5	0	do.
„ „	1	1	0	0	0	3	0	do.
„ Mortar.	1	0	0	9	25	0	0	On a truck Carriage.
„ Swivels. .	1	0	8	0	0	3	6	Unserviceable.

Abstract of Ordnance.

Guns Iron Malabar	29
Swivels do.	32
Gingalls do.	2
Mortars do.	8
Guns Brass	8
Swivels do.	1
Mortars do.	1
Total of Ordnance....	81

N. B.—About 50,000 lbs. Gunpowder.
35,000 „ Saltpetre.
18,000 Musket Balled Cartridges.
A large Godown, full of Ground Rockets.
about, 35,000 Hammered Shot from 1 to 24 pdrs.
Blue Lights, great quantity.

Digitized by Google

STATEMENT OF THE NUMBER OF ORDNANCE AT THE FOLLOWING SIEGES.

Years.	Sieges.	Guns.						Mortars.				Howitzers.			
		Iron.			Brass.			Brass.				Brass.			
		24 Pounder.	18 Pounder.	12 Pounder.	12 Pounder.	6 Pounder.	3 Pounder.	13 Inch.	10 Inch.	8 Inch.	5⅘ Inch.	8 Inch.	5½ Heavy.	5½ Light.	4⅕ Inch.
1804	Dieg	0	6	0	4	6	0	0	0	4	4	0	4	0	0
1805	Bhurtpoor	2	6	4	9	60	0	0	1	4	4	0	10	2	2
1807	Kamona	0	6	0	3	4	0	0	0	0	2	2	0	2	0
1807	Gunnourie	0	6	0	3	4	0	0	0	0	2	2	0	2	0
1809	Adjeegurh	0	4	2	0	8	0	0	0	0	0	2	2	0	0
1817	Nagpoor	0	0	0	0	7	0	0	0	0	0	0	2	1	0
1817	Kutterah and Fort Hattrass	6	14	0	0	18	0	0	6	14	22	4	0	0	0
1818	Singhur	0	4	2	2	0	0	0	1	4	0	0	2	0	0
1818	Belgaum	0	2	2	2	0	0	0	0	2	0	0	0	0	0
1818	Sholapore	9	2	3	3	8	0	0	0	3	1	0	3	0	0
1818	Rajdeir	0	2	2	0	8	0	0	0	2	1	2	2	0	0
1818	Trimbuck	0	2	2	0	8	0	0	0	2	2	2	2	0	0
1818	Malligaum	0	10	2	3	8	0	0	1	5	1	2	4	0	0
1818	Chanda	0	3	0	4	4	0	0	0	0	0	0	6	0	0
1819	Asseerghur	2	19	3	4	0	0	0	4	8	3	6	2	7	10
1819	Nowa	0	3	0	0	2	0	0	0	2	2	0	2	0	0
1819	Copal Droog	0	4	2	2	0	0	0	0	8	1	0	2	0	0
1826	Bhurtpoor	16	20	4	14	26	0	2	12	46	0	12	10	0	0
1824	Rangoon*	0	4	6	0	6	2	0	0	2	2	1	2	0	8

* This is the number actually sent from Madras for the expedition. The above is taken from the published accounts of Sieges; regimental guns are not included, in many of the old seiges each battalion had two 6 pounders.

Digitized by Google

STATEMENT OF THE EXPENDITURE OF SHOT AND SHELLS AT THE FOLLOWING SIEGES.

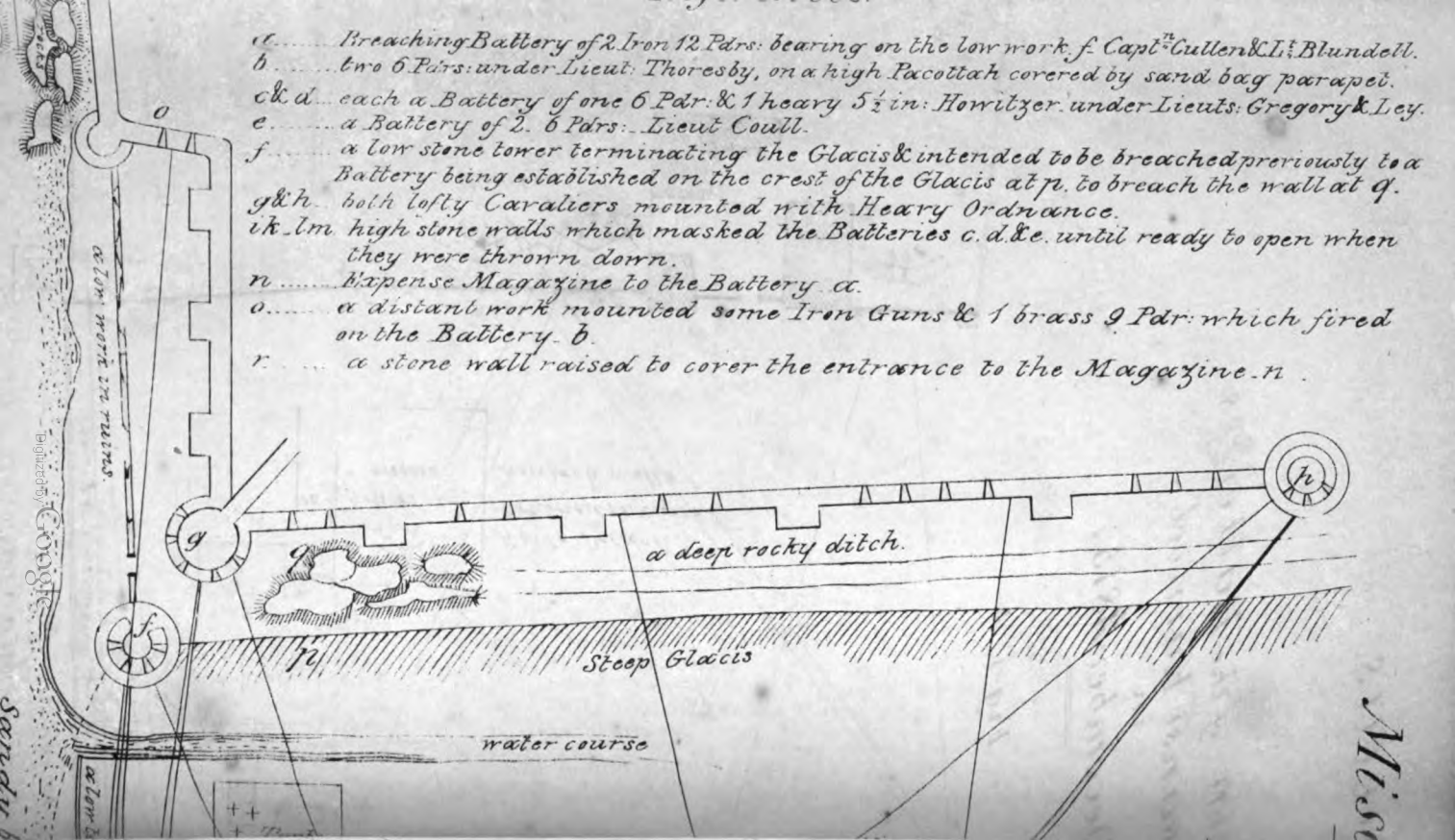
Years.	Sieges.	Shot.												Shells.				Carcases.
		Round.				Spherical.				Canister.				Common.				
		24 Pounder.	18 Pounder.	12 Pounder.	6 Pounder.	24 Pounder.	18 Pounder.	12 Pounder.	6 Pounder.	24 Pounder.	18 Pounder.	12 Pounder.	6 Pounder.	13 Inch.	10 Inch.	8 Inch.	5½ Inch.	8 Inch.
1804	Dieg	0	4560	204	0	0	0	0	0	0	14	0	0	0	0	342	797	0
1805	Bhurtpoor	18.331	22,533	40	92	345	521	36	0	639	391	0	16	236	4 506	13.839	0	4
1807	Kamona	0	50,36	2.341	0	0	14	0	0	0	14	0	0	0	0	286	603	0
1807	Gunnourie	0	2,245	12	0	0	0	0	0	0	53	12	0	0	0	79	174	0
1809	Adjeegurh	0	2053	787	120	0	0	0	0	0	23	0	38	0	0	268	0	10
1817	Nagpoor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150	0
1817	Kutterah and Fort Hattrass	1745	2730	0	0	0	0	0	0	0	0	0	0	0	463	930	1711	0
1818	Singhur	0	2300	0	0	0	0	0	0	0	0	0	0	0	120	717	580	0
1818	Rajdeir	0	90	41	0	0	0	0	0	0	0	0	0	0	0	38	2	0
1818	Trimbuck	0	254	66	0	0	0	0	0	0	0	0	0	0	0	111	40	0
1818	Malligaum	0	3462	2395	500	0	0	0	0	0	0	21	50	0	98	1004	233	6
1819	Nowa	0	1380	0	462	0	0	0	0	0	2	0	67	0	0	213	1040	0
1824	Rangoon*	0	4000	6000	1020	0	200	966	480	0	80	530	300	0	0	300	515	100

* This is the number actually sent from Madras for the expedition, with 300 Congreve Rockets, 200 Handgrenades, and 400 double headed Shot. The above expenditure is taken from the published accounts of sieges.

Digitized by Google

Digitized by Google

c. ..... Breaching Battery of 2 Iron 12 Pdrs: bearing on the low work f. Capt[n] Cullen & Lt[t] Blundell.
b. ..... two 6 Pdrs: under Lieut: Thoresby, on a high Pacottah covered by sand bag parapet.
c & d. ... each a Battery of one 6 Pdr: & 1 heavy 5½ in: Howitzer under Lieuts: Gregory & Ley.
e. ..... a Battery of 2. 6 Pdrs: Lieut Coull.
f. ..... a low stone tower terminating the Glacis & intended to be breached previously to a Battery being established on the crest of the Glacis at p. to breach the wall at q.
g & h. ... both lofty Cavaliers mounted with Heavy Ordnance.
i k l m ... high stone walls which masked the Batteries c. d. & e. until ready to open when they were thrown down.
n. ..... Expense Magazine to the Battery a.
o. ..... a distant work mounted some Iron Guns & 1 brass 9 Pdr: which fired on the Battery b.
r. ..... a stone wall raised to cover the entrance to the Magazine n.



Digitized by Google

neous.

ion of the Batteries
ainst Kurnool
in
December 1815.

Fig: 1.

Digitized by Google

List *of Ordnance, Carriages, Ammunition, and Stores, supplied from the Arsenals of Fort St. George, Bangalore, Bellary, and Secunderabad for the use of the Kurnool, Field Force.—August* 1839.

Articles.	From Fort Saint George	From Banga-lore.	From Bella-ry.	From Secun-der-abad.	Total.	Remarks.
	No.	No.	No.	No.	No.	
Ord. Iron with carriages and Limbers, 18 Pdr....	0	0	4	0	4	
" " " 12 " ...	0	1	4	0	5	
" " mor. with beds 8in.	0	0	0	3	3	
" brass " " 8 "	0	0	1	0	1	
" " " " 5½in.	0	0	0	4	4	
" " heavy Howt. Car. & Limber 5½in.	0	0	1	3	4	
Carts, Ammunition.....	0	0	3	10	13	
" Mortar..... light ...	0	0	2	3	5	
" Platform.....	0	0	14	71	85	
" Laboratory.....	0	0	0	1	1	
" Artificers	0	0	0	1	1	
" Forge with bellows complete...	0	0	1	0	1	
Carriages transporting with limber.....	0	0	4	0	4	
" with limber spare 12pdr.	0	0	1	0	1	
Platforms, Mortar...	0	0	2	4	6	
" Gun skeleton.....	0	0	6	2	8	
Ammunition.						
Balls, fire..... ..... 8in.	0	0	8	0	8	
" " ..... 5½ "	0	0	21	0	21	
Carcasses iron filled... 8 "	100	0	0	0	100	
Cartridges cloth empty 18pdr	0	0	3,300	0	3,300	
" " " 12 pdr.	0	0	3,300	0	3,300	
" " " 8in.	0	0	1,350	0	1,350	
" " " 5½ "	0	0	1,000	0	1,000	
" " filled for bursting common shells 5½ inch	0	0	600	0	600	
" " " S C.S. 18pdr.	0	0	200	0	200	
" " " ..... 12 "	0	0	200	0	200	
" " " ..... 5½ "	0	0	50	0	50	
Cartridges cloth empty bursting comn. sh. 5½in.	0	0	0	874	874	
" " " " S.C. shot 5½in,	0	0	0	99	99	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Fort Saint George	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	No.	
Car., cloth filled bursting Howtz. 12ozs....5½in.	0	0	0	153	153	
„ „ empty „ „ 12 pdr.	0	0	0	12	12	
„ „ „ ..... 6 ozs.	0	0	0	6	6	
„ „ filled ..... 6 „	0	0	0	51	51	
„ Serge „ How. ...5½in.	0	0	200	264	464	
„ „ empty „....5½ „	0	0	1,100	540	1,640	
Fuzes, drove, common 8 „	1,500	0	500	539	2,539	
„ „ „ 5½in.	3,000	0	500	2,450	5,950	
„ „ sphrl. case shot	0	0	1,795	250	2,045	
Gunpowder.....Madras L: G...lbs.	0	22,500	33,300	22,497	78,297	
„ „ S.G. „ ..	0	0	315	90	405	
„ „ mealed „	0	0	45	45	90	
Lights, blue	0	0	30	50	80	
Match, cotton .....skeins.	0	0	57	54	111	
„ country..... „	0	0	11	0	11	
„ quick ..... „	0	0	15	14	29	
Portfires, drove.....	0	0	200	200	400	
Rockets, signal.....	0	0	30	0	30	
Shot, iron round....18 pdr.	0	0	3,200	0	3,200	
„ „ „ ....12 „	0	0	3,200	0	3,200	
„ canister grape 18 „	0	0	400	0	400	
„ „ „ 12 „	0	0	400	0	400	
„ „ „ 5½ inch	0	0	0	100	100	
„ Sph. case filled 18pdr.	0	0	200	0	200	
„ „ „ 12 „	0	0	200	0	200	
„ „ „ 5½ „	0	0	50	200	250	
Shells, common....8 „	1,000	0	350	650	2,000	
„ „ ....5½ „	0	0	2,600	1,000	3,600	
Small Arm Ammunition.						
Balls, leaden 1st size.. ..	0	0	13,650	0	13,650	
Cartridges, shotted musket	0	260,000	500,000	96,000	856,000	
„ „ rifle ..	0	0	13,650	0	13,650	
„ „ fuzil ..	0	0	9,800	3,000	12,800	
„ „ pistol ..	0	6,949	31,950	0	38,899	
Flints, musket	0	25,000	53,445	11,200	89,645	
„ rifle and fuzil.....	0	2,000	2,888	800	5,688	
„ pistol.....	0	0	3,195	0	3,195	
Patches, greased...	0	0	13,650	0	13,650	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	
Stores.					
Adzes, brass Coopers.....	0	3	2	5	
„ iron „	0	1	0	1	
„ „ Carpenters. ...	0	3	0	3	
Anvils „ Smiths.	0	3	0	3	
Augers Carpenters...	0	3	0	3	
„ Fuze brace.....	0	2	6	8	
„ „ hand	0	2	6	8	
Aprons, Canvas.....	0	8	0	8	
Axes, broad with helves....	0	40	10	50	
„ hand „ „ ..	0	250	50	300	
„ felling „ „ ..	0	31	10	41	
„ pick „ „ ...	0	105	50	155	
Axletrees, Iron.....	0	5	0	5	
Bags, gunny powder.	0	134	0	134	
„ „ Shot and shell.	0	1,465	380	1,845	
„ „ Ammunition .	0	965	104	1,069	
„ „ Tools & stores	0	109	0	109	
„ Canvas powder.....	0	0	3	3	
Bamboos, large.....	0	0	125	125	
„ small..... ..	0	400	60	460	
Barrels, powder 90lbs with 4 Copper hoops.	0	0	242	242	
„ „ 45 „ „ 4 „ „ „ ..	500	748	18	1,266	
„ Budge „ 4 „ „ „ ..	0	4	2	6	
„ Ammun. „ 4 „ „ „ ..	0	0	198	198	
„ „ empty with copper hoops...	0	611	0	611	
„ Flint „ „ iron „ ...	0	25	0	25	
Barrows, hand,.....	0	8	0	8	
Baskets, common.....	0	200	50	250	
Bearers, leather for shells...	0	3,950	1,000	4,950	
Bellows, forge Eur. large pairs...	0	1	1	2	
„ „ Country small „ ...	0	20	2	22	
„ Hand for proving shells.	0	2	2	4	
Benches, Fuze with Staples.	0	2	3	5	
„ Standing Vice	0	1	0	1	
„ Armourer.....	0	1	0	1	
Bits, Gun steel large.....	0	10	0	10	
„ „ „ small	0	10	22	32	
Bistelas .....Cubits....	0	20	0	20	
Borax.....lbs...	0	15	5	20	
Bottles, copper filled with Spirits of Wine ..	0	4	3	7	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	
Bottles Common..	0	0	4	4	
Boxes, Copper dredging.. ..	0	2	10	12	
„ Quick match.....	0	2	10	12	
„ Fuze wooden.....	0	0	3	3	
„ Packing of sizes....	0	0	4	4	
„ Ammunition copper clamps.	0	540	0	540	
„ Shot and Packing....	0	176	0	176	
Brass, Old ..... lbs...	0	40	10	50	
Brushes, painting hair.....	0	6	0	6	
Buckets, Gun leather.....	0	10	10	20	
„ „ wooden.....	0	0	3	3	
„ Tar „	0	11	5	16	
Buntin of Colours...pieces...	0	6	2	8	
Camphor .....lbs ..	0	6	0	6	
Candles, wax.....	0	100	36	136	
Canvas, Fur....bolts & yds...	15	15	4,10	34,10	
Cases, packing of sorts.....	0	0	18	18	
Chains, measuring	0	1	1	2	
Chalk ....lbs...	0	20	6	26	
Chest, Laboratory & cart complete....	0	1	0	1	
„ „8 and 5½ inches	0	0	2	2	
„ Arm with hinges....	0	1	0	1	
Chisels of sizes.....	0	15	0	15	
Cloth, white Punjum. 72 Cubits—Pieces.	0	15	5	20	
„ „ blue 30 „ „ ...	0	0	2	2	
„ Waxed.... Cubits..	0	40	6	46	
„ Canvas powder....	0	5	4	9	
Coins Gun upper.....	0	12	0	12	
„ „ under	0	12	0	12	
„ Mortar.....	0	2	0	2	
Coir, loose.....lbs...	0	150	50	200	
Collars, Bullock leather.... .	0	182	0	182	
Colors, Camp with staves large...	0	0	6	6	
„ „ „ „ small.....	0	0	10	10	
Compasses, brass common pairs...	0	2	16	18	
„ „ Gunners „ ...	0	7	6	13	
„ iron Common.....	0	2	1	3	
„ „ Calibre large & small.	0	2	2	4	
Coal, char... .....Bushels...	0	0	4	4	
Crows, Iron common.....	0	30	20	50	
Cylinders, tin for Mortars 8 inch....	0	1	3	4	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	
Cylinders, tin for Mor. 5½in.	0	0	4	4	
Dammer... .....lbs...	0	30	20	50	
Drivers, brass Coopers.....	0	3	2	5	
„ and Setters for Fuzes 8 inch...sets....	0	2	6	8	
„ „ „ 5½ „ „	0	2	14	16	
Duppahs	0	0	4	4	
Emery .....lbs..	0	8	0	8	
Engines, Fuze large.....	0	0	1	1	
„ „ small.	0	2	1	3	
Esses, iron..	0	84	20	104	
Fellies, for Ammun. carts...	0	0	12	12	
„ „ Platform „ ..	0	0	64	64	
„ of Sizes.....	0	74	0	74	
Files, three square for Saws.	0	2	0	2	
„ of sorts..	0	50	41	91	
Fishes, Gun with Staves. ...	0	2	2	4	
Flags, Brigadier 12 feet by 9 with Staff.....	0	1	2	3	
„ Union Comg. Officer's.	0	0	1	1	
Formers, cartridges. gun 18pr.	0	2	0	2	
„ „ „ 12 „ ...	0	2	0	2	
„ „ Mortar 8 Inch...	0	1	0	1	
„ „ „ 5½ „ ...	0	1	1	2	
„ „ Howr. 5½ „ ...	0	1	1	2	
Funnels, copr. large & small.	0	3	6	9	
„ tin.	0	2	2	4	
Gauges, iron for shot & shell.	0	0	2	2	
„ brass for shells 8in.set.	0	1	0	1	
„ „ „ „ 5½ „	0	1	0	1	
„ „ „ shot 18pdr. „	0	2	0	2	
„ „ „ „ 12pdr. „	0	2	0	2	
„ wooden for Wads 18 „ „	0	2	0	2	
„ „ „ „ 12 „ „ ..	0	2	0	2	
Gimlets, carpenters of sizes.	0	12	10	22	
Gins, complete with spare falls, blocks, and hand-spikes.....	0	1	1	2	
Glasses, prespective.....	0	2	2	4	
Glue.....lbs...	0	15	10	25	
Grates, for heating shot with carriers, rakes &c. complete.....	0	1	0	1	
Grease.....Gallons.....	0	0	63	63	
Hemp, thick...of 20 cubits Pieces...	0	70	0	70	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	
Gunny, broad & narrow pieces	0	0	30	30	
Hammers, claw.....	0	15	7	22	
„ Sledge.....	0	6	1	7	
„ Hand.....	0	10	7	17	
Handspikes traversing 18pdr.	0	8	0	8	
„ „ 12 „	0	8	0	8	
„ „ 5½ inch	0	1	0	1	
„ „	0	0	6	6	
„ purchasing.....	0	73	30	103	
Haversacks, Gun leather....	0	30	12	42	
Heads, rammer common. 18 pdr.	0	6	0	6	
„ „ „ 12 „ ...	0	6	0	6	
„ Concave 18 „	0	6	0	6	
„ „ „ 12 pdr...	0	6	0	6	
„ „ „ 5½ inch...	0	1	0	1	
„ Spunge Gun 18 pdr.	0	6	0	6	
„ „ „ 12 „	0	6	0	6	
Helves, for Mamoties spare.	0	70	0	70	
„ „ Axe broad „	0	12	0	12	
„ „ „ felling „	0	12	0	12	
„ „ „ pick.....	0	100	0	100	
Hooks, bill.....	0	200	100	300	
Hooks, washer.....pairs...	0	12	0	12	
Hoops, copper spare for Powder barrels...	0	0	12	12	
Husk, Paddy..... Bushel...	0	0	1	1	
Instruments, Gunner Spirit perpendicular.	0	6	10	16	
„ „ Quadrant, plummet..	0	6	5	11	
„ „ „ Spirit....	0	0	5	5	
„ Vices Fuze wooden	0	5	6	11	
„ For sph. case shot of sorts	0	0	1	1	
„ Pincers fuze brass..pairs	0	0	10	10	
Inshavers Cooper.....	0	1	0	1	
Iron, priming large & small..	0	35	12	47	
„ Bolt..... .....lbs ..	0	400	100	500	
„ Square ..... „	0	800	200	1,000	
„ Flat..... „	0	800	200	1,000	
„ Hoop..... „	0	150	50	200	
„ Rod..... „	0	70	30	100	
„ Beak..... „	0	3	1	4	
„ Caulking..... „	0	1	1	2	
„ Soldering ..... „	0	1	1	2	
„ Old..... „	0	150	180	330	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	
Jacks, hand large & small...	0	2	2	4	
Junk, Europe..... lbs ..	0	400	100	500	
Kettles, iron pitch...	0	1	1	2	
Knives, Laboratory.....	0	12	6	18	
„ Clasp.....	0	28	4	32	
„ Grass..... ..	0	0	20	20	
Ladders, scaling.....	0	0	10	10	
Ladles, iron dipping.....	0	1	1	2	
„ „ melting...large...	0	1	1	2	
„ „ „ ...small...	0	1	1	2	
„ copper with worms 18pr.	0	8	0	8	
„ „ „ „ 12 „	0	6	0	6	
Lanterns, dark	0	3	2	5	
„ muscovy.	0	3	3	6	
Lead, white..... lbs. ...	0	40	0	40	
„ red..... „ ...	0	40	0	40	
Leather, tanned country hds.	0	10	5	15	
Line, hambro..... skeins. .	0	9	5	14	
„ deep sea.... „ ...	0	8	2	10	
„ log ..... „ ...	0	35	15	50	
„ hand..... „ ...	0	6	0	6	
„ mer..... „ ...	0	7	10	17	
Linstocks with cocks.....	0	20	0	20	
Locks, pad with keys, iron double	0	8	0	8	
„ „ „ „ single...	0	23	40	63	
„ „ „ brass	0	0	2	2	
Mamoties, with helves ..	0	68	100	168	
Measures, copper, powder, large...sets...	0	1	0	1	
„ „ „ small... „	0	1	2	3	
Nails of sorts, copper lbs.	0	15	5	20	
„ „ „ iron „	0	125	25	150	
„ „ „ tinned „	0	50	0	50	
Needles, gunny	0	150	50	200	
„ sail.....	0	75	25	100	
„ sewing	0	175	100	275	
Nets, coir for wads.....	0	19	0	19	
Oakum, Europe.... .lbs...	0	200	500	700	
Oil, cocoanut..... gallons ..	0	35	1	36	
„ linseed ..... „ ...	0	35	0	35	
Paint, mixed black....lbs...	0	50	0	50	
„ „ white.... „ ...	0	50	0	50	
„ „ blue .... „ ...	0	100	0	100	
„ in powder, lampblack „	0	5	0	5	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	
Palms, hand, steel.....	0	15	5	20	
Paper, portfire Europe, qrs.	0	10	10	20	
„ „ country „	0	9	0	9	
Pegs, tent.....	0	600	0	600	
Perambulator.....	0	1	0	1	
Pickets, park.....	0	30	20	50	
„ platform.....	0	58	0	58	
Pincers, brass fuze...pairs...	0	2	0	2	
„ iron „ ... „ ...	0	2	14	16	
„ „ common „ ...	0	10	0	10	
Pins, linch...spare.....	0	30	0	30	
„ iron yoke.....	0	30	0	30	
Pitch.....barrels...	0	1	1	2	
Planes, of sorts.....	0	6	0	6	
Plate screws with taps, large	0	4	4	8	
„ „ „ small	0	11	8	19	
Poles spare for ammn. carts	0	0	2	2	
„ „ platform „	0	0	4	4	
Pouches, priming....country	0	30	20	50	
Punches, shell.....	0	0	6	6	
Rasps, of sorts.....	0	27	20	47	
Reels, camp with line	0	7	5	12	
Relievers, for spring spikes	0	9	3	12	
Resin. .....lbs...	0	40	10	50	
Rivets, copper..... „ ...	0	4	1½	5½	
Rods, measuring..10 feet...	0	3	0	3	
„ „ ... 5 „ ...	0	3	0	3	
„ „ ... 3 „ ...	0	3	0	3	
„ „	0	0	3	3	
Rope, Europe...2in..fathoms	0	0	108	108	
„ „ 4½ „ coils..	0	1	0	1	
„ „ 3½ „ „ ...	0	1	0	1	
„ „ 2½ „ „ ...	0	2	0	2	
„ „ 1½ „ „ ...	0	2	0	2	
„ country 2½ & 1½in. ...	0	5	0	5	
„ „ 3 & 2 „ „ ...	0	0	21	21	
„ cotton.....skeins...	0	40	0	40	
„ ratline..... fathoms...	0	190	130	320	
„ tent white .....yds...	0	0	250	250	
„ „ blue..... „ ...	0	0	100	100	
„ drag heavy field...sets	0	17	0	17	
„ „ light „ 5½in „	0	1	0	1	
„ „ gun..... ..... „	0	0	10	10	
Rubbers, file.....	0	4	5	9	
Rulers, in cases.....	0	4	0	4	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No	No.	No.	No.	
Sal-ammoniac.....lbs...	0	17	7 1/10	24 1/10	
Saws, pit	0	1	0	1	
„ cross cut.....	0	1	1	2	
„ hand	0	3	0	3	
„ fuze.....	0	10	10	20	
„ tennant.....	0	1	0	1	
Scales, copper, large..prs...	0	1	0	1	
„ „ small... „ ...	0	2	2	4	
„ „ „ with wooden triangle...prs.	0	0	1	1	
„ wooden with triangle and weights	0	1	0	1	
„ Gunter's brass.....	0	4	6	10	
Scissors, Laboratory...prs...	0	40	10	50	
Scrapers, shell.....8in...	0	1	2	3	
„ „ .....5½ „ ...	0	1	0	1	
„ gun..... 18pdr.	0	2	0	2	
„ „ ..... 12 „	0	2	0	2	
„ mortar.... 8in...	0	1	0	1	
„ „ .. .5⅝ „ ...	0	1	0	1	
„ howitzer...5½ „ ...	0	1	0	1	
Screws, iron for wood of sizes....dozens	0	50	25	75	
Searchers, gun with relievers	0	3	2	5	
Serge, common....pieces...	0	10	10	20	
Setters, steel for saws.....	0	8	0	8	
Sheers, Tinman's ... prs...	0	1	0	1	
Sieves, powder, brass wire ...single	0	1	1	2	
Sinnet, for spunges...balls...	0	12	8	20	
Skins, sheep untanned.....	0	0	17	17	
Slings, mortar.....	0	0	2	2	
Solder, copper.....lbs...	0	7	3	10	
„ pewter ..... „ ...	0	7	3	10	
Spades.....	0	10	15	25	
Spikes, gun ragged.....	0	9	10	19	
„ „ round	0	9	10	19	
„ „ spring.....	0	9	10	19	
Spirit, of Turpentine, bottles	0	6	2	8	
„ „ wine „	0	0	3	3	
Spunges, with rammer head...18 pdr.	0	8	0	8	
„ „ „ „ ...12 „ ...	0	8	0	8	
„ „ „ .....8 inch...	0	2	0	2	
„ „ concave „ 18pdr.	0	5	0	5	
„ „ „ 12 „	0	5	0	5	
„ „ „ 5½ in...	0	3	0	3	
„ caps 18pdr.	0	13	0	13	
„ „ .....12 „	0	13	0	13	
„ „ .... 8in.	0	2	0	2	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Bangalore.	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	
Spunge, caps.....5½ in.	0	3	0	3	
" howitzer.....5⅝ "	0	0	8	8	
" mortar.....8 "	0	0	8	8	
" " .....5½ "	0	0	9	9	
Spunyarn.....rolls ..	0	30	30	60	
Spokes, for ammunition carts	0	0	12	12	
" " platform "	0	0	21	21	
" " car. wheels of sorts	0	84	30	114	
Staff, bamboo, Brigr. complete	0	0	1	1	
Staves, spunge country.....	0	11	0	11	
Steel, Europe.....lbs...	0	67	50	117	
Stocks, lint with cocks.....	0	0	12	12	
" portfire	0	10	10	20	
Stone, grinding with trough	0	1	0	1	
" oil, Turkey complete	0	1	0	1	
Tacks, copper spunge...lbs..	0	6	4	10	
" iron..... "	0	3	2	5	
Tarpaulins, magazine, large	6	22	4	32	including 31 from Fort Saint George
" " small	24	46	4	74	
" cart.....	50	92	105	278	
" limber.	0	10	3	13	
" ammun. cart or wag.	0	3	11	14	
Tar & grease mixed filled kg.	0	28	27	55	
" common filled...barrels	0	3	2	5	
Tape, Broad.....yds...	0	0	100	100	
" Narrow..... " ...	0	0	50	50	
Thread, Cotton.....lbs...	0	75	25	100	
" Silk... .....ozs...	0	6	3	9	
Ticken.....pieces...	0	0	3	3	
Timber, teak sheathing .bds.	0	14	0	14	
" " ½ arties....	0	2	0	2	
" " ¼ duggies..	0	2	0	2	
" " Shimbeam...	0	4	0	4	
" Jungle wood large, for Axletrees, fellies, and Spokes...pieces	0	6	0	6	
Tin, single.....sheets...	0	80	30	100	
Traces, chain iron gun..1½pr	0	4	0	4	
" " " .....12 "	0	5	0	5	
" " how. 5½in..	0	1	3	4	
" " " ammn. cart.	0	3	10	13	
" " " platform "	0	40	72	112	
" " " Transport carge.	0	4	0	4	
" " " Mortar cart.	0	0	3	3	
Tutenague.....lbs....	0	6	4	10	
Twine, Country.....skeins.	0	100	50	150	
" Europe fine "	0	100	0	100	
" " ... coarse "	0	50	50	100	
" Gunny.....lbs...	0	175	65	240	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Fort Saint George	From Bellary.	From Secunderabad.	Total.	Remarks.
	No.	No.	No.	No.	
Vices, brass cooper's.....	0	3	2	5	
" iron bench.....	0	6	6	12	
" " hand.....	0	6	0	6	
" " standing..	0	2	1	3	
Vittery.....yards....	0	157	184	341	
Wads, Gun.....	0	6,500	0	6,500	
Washers, iron spare..... ...	0	32	0	32	
Wax, bees.....lbs ...	0	15	10	25	
Weights, brass...28 lbs..sets.	0	0	1	1	
" " ... 4 " "	0	0	1	1	
Whips Bullocks.....	0	0	30	30	
Wrenches, iron for screw nuts	0	7	5	12	
Yokes, Quadruple pole.....	0	48	9	57	
" " trace. ...	0	102	6	108	
" common pole.....	0	22	90	112	
" " trace.....	0	107	111	218	
" new muster.....	0	7	24	31	
For the Engineers, Sappers and Miners.					
Axes, pick...	0	200	0	200	
" felling.....	0	50	0	50	
" hand.....	0	200	0	200	
" broad.....	0	25	0	25	
Bags, sand leather	0	2,879	0	2,879	
" " dungaree	12,000	7,944	0	19,944	
" " gunny.	0	3,032	0	3,032	
Baskets country...	0	200	0	200	
Chokers, fascine..... ...	0	10	0	10	
Crow-bars.....	0	25	0	25	
Hammers, sledge..... ..	0	10	0	10	
" hand.....	0	6	0	6	
Helves, for Mamoties...	100	500	0	600	
" " Axes-pick..	0	300	0	300	
" " " felling.....	0	100	0	100	
" " " hand	0	200	0	200	
" " " broad.	0	50	0	50	
Hooks, bill...	0	250	0	250	
" sap with staves..	0	20	0	20	
Jumpers, iron.....	10	0	0	10	
Knives, clasp.....	19	0	0	19	
" Laboratory.....	31	0	0	31	
Ladders, escalading.....	0	25	0	25	
Line Hambro ....skeins...	10	0	0	10	
" Log Europe.... " ...	10	0	0	10	
Mallets, wooden.....	0	10	0	10	
Mamoties,.....	100	300	0	400	
Prickers, copper.....	10	0	0	10	
Rods, priming brass.....	9	0	0	9	
" " copper.....	1	0	0	1	

Digitized by Google

List of Ordnance, &c. continued.

Articles.	From Fort Saint George	From Bellary.	Total.	Remarks.
	No.	No	No.	
Saws, cross cut	4	0	4	
Shovels, Europe	150	49	199	
Tools, Carpenter's ....chest....	1	0	1	
Wedges, iron large	5	0	5	
„ „ small	14	0	14	
By order of the officer Comg. Ceded Districts for two 6 Pdrs.				
Bottles, copper with spirits of wine....	0	4	0	
Boxes, „ for Ammun. Cart.....	0	3	0	
„ „ dredging with 1lb meald. pdr.	0	4	0	
„ Quick match with 1 skein each.	0	4	0	
„ Fuze with 30 in each	0	4	0	
Bucket, wooden tar	0	1	0	
Cartridges, serge filled 1¼ lb. 6 pdr.	0	740	0	
„ „ empty.... 6 „	0	80	0	
„ cloth filled, burstg. 2¼ ozs 6 „	0	72	0	
Carts, Ammmunition	0	6	0	
Cloth, waxed .....cubits.....	0	8	0	
Fellies..	0	3	0	
Locks, pad with keys iron single.....	0	18	0	
Match, cotton .....Sks.	0	12	0	
Oakum, Europe. .....lbs....	0	240	0	
Pole, for Ammunition cart	0	1	0	
Portfires, drove	0	240	0	
Rope, Europe 1½ inch.....fathoms.	0	85	0	
Shot, iron round fixed to botms..6 pr.	0	278	0	
„ tin canister.....6 „	0	216	0	
„ Spherical case.....6 „	0	72	0	
Spokes...	0	3	0	
Tarpaulins, Ammunition cart.....	0	6	0	
Tar and Grease filled.....kegs....	0	1	0	
Traces, chain for ammunition cart....	0	6	0	
Twine, Europe coarse ....skeins....	0	8	0	
Yokes, new muster	0	16	0	

Articles.	From Bellary.	Remarks
	No.	
Supplied to Her Majesty's 39th Regt.		
Cartridges, shotted musket	30,000	
„ „ fuzil	1,800	
Flints, musket	3,000	
„ fuzil	180	
Supplied to 39th Regiment N. I.		
Cartridges, shotted musket	23,327	
Flints	119	

Digitized by Google

LIST OF ORDNANCE, STORES, &c. IN THE FORTRESS OF KURNOOL ASCERTAINED BY THE COMMITTEE OF WHICH MAJOR BOND WAS PRESIDENT, 15TH OCTOBER 1839.

ARTICLES.	No.
Gunpowder loose ..... lbs	211,663
Saltpetre loose ..... „	857,601
Sulphur loose ..... „	273,020
Cartridges Shotted Ginjal ..... No.	220
„ Blunt Musket ..... „	2,600
„ Shotted „ ..... „	238,000
„ Cloth filled, in No. 58,342, from 2 oz. to 40 lbs. containing Gunpowder .. lbs	52,852
„ Cloth empty of sizes from 1 to 42 pdrs	51,000
Ordnance Brass Howitzers	66
„ Iron do.	67
„ Brass Mortars	3
„ „ Guns	98
„ Iron „	63
„ Brass Ginjals	270
„ Iron „	15
„ Camel Pieces	11
„ Iron Wall Pieces	7
Bottoms Shot of sizes	527
Balls leaden loose of sizes ..... lbs	11,200
Shells Spelter filled and fuzed of sizes	2,027
Canisters for Grape Tin empty	9,800
„ „ „ Copper „	42
Shot Canister Copper Grape filled with balls 10 inch ..	1
„ „ Chain of sizes	616
„ Grape Quilted of sizes	259
„ „ Spindle „	769
„ Canister Tin filled with Spelter balls	749
„ Iron loose round from 1 to 42 pdr	79,762
Shells common empty Spelter of sizes from 1 to 25 inches diameter	24,583
„ Empty 5 feet diameter	1
„ „ Spelter S. C. of sizes	323
Shot Bar with Spelter heads	100
„ Round loose Spelter of sizes from ½ to 32 pdrs	72,137
Fuzes drove and graduated of sizes	2,060
Match Quick Boxes large	2
„ Cotton ..... Skeins	44
Measures Copper	2
„ Tin	2

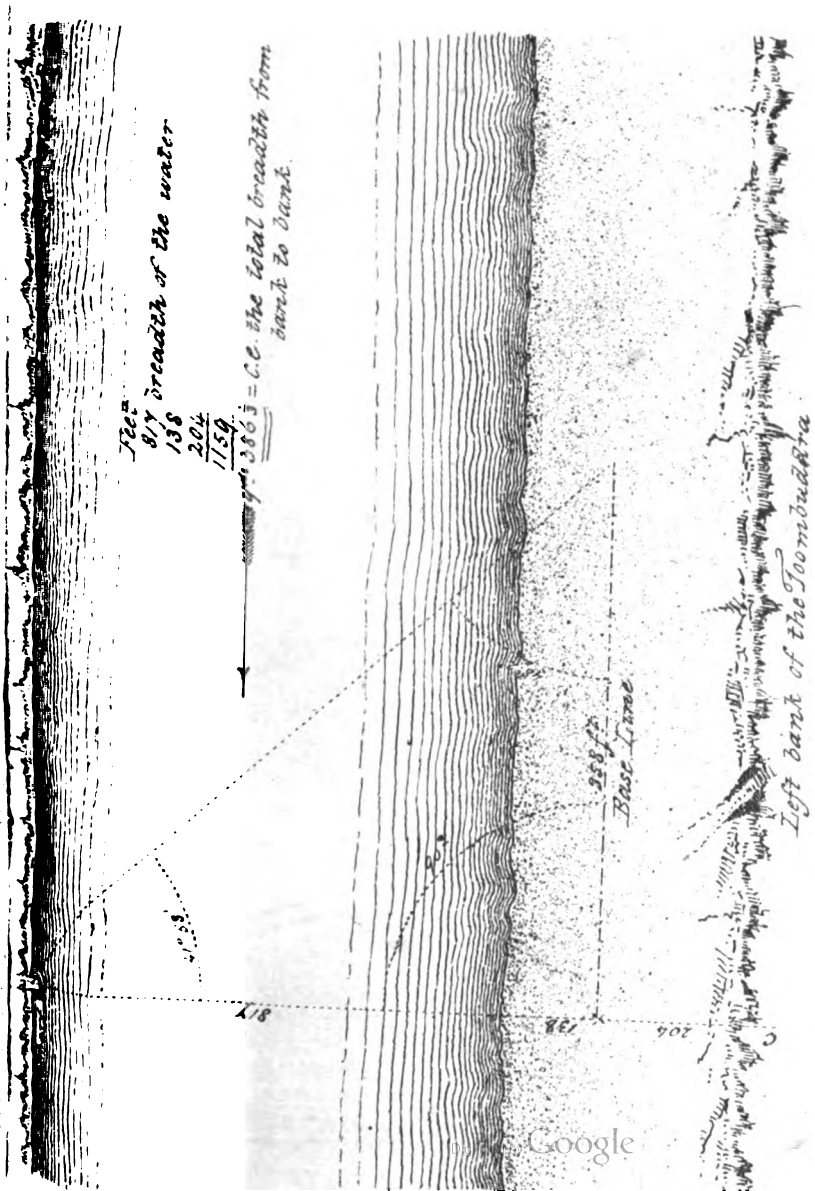
Digitized by Google

Articles.	No.
Armlets	15
Axes Battle	2
Bayonets Musket	1,313
Blunderbusses	2
Belts Country Leather Brown	100
Fowling pieces double Barrel	31
„ „ Single „	17
Musket with double Cylinders Self-loading	1
Helmets Chain	12
Muskets Common	2,966
„ Barrels	1,049
„ Locks	415
„ Stocks	19
Matchlocks	107
Maces Iron	2
Pistols double Barreled	2
„ Single „	235
„ Barrels	375
Pouches Country Leather Brown	550
Plates, Brass Breast	17
Rings Brass Round	60
Rifles Single Barreled	2
Swords with Scabbards	469
Spears with Shafts	83
Shirts of Mail	84
Shields	3
Tubes	1
Flints Musket and Pistol	51,388
Daggers with Sheaths	86
Copper in Sheets, Plates and Ingots lbs.	14,315
Iron Ore „	4,469
Iron Wrought of sorts „	67,000
Lead in Sheet and Pig „	47,912
Tin in Sheet Pieces	19,420
Zinc in Plate and Pieces lbs.	14,271
Steel in Bar and Pieces „	1,500
Borax Bags	2
Salammoniac lbs.	10
Solder Soft „	16
Axletrees Iron Wrought	9
Chains Iron Trace of sorts and lengths	282
„ Small measuring feet	152
Coals Europe Bags	6
Candles Wax	146
Cylinders Copper	11
Doors Iron Old	22

Digitized by Google

Breadth of the Toombuddra River at Humpsaughur

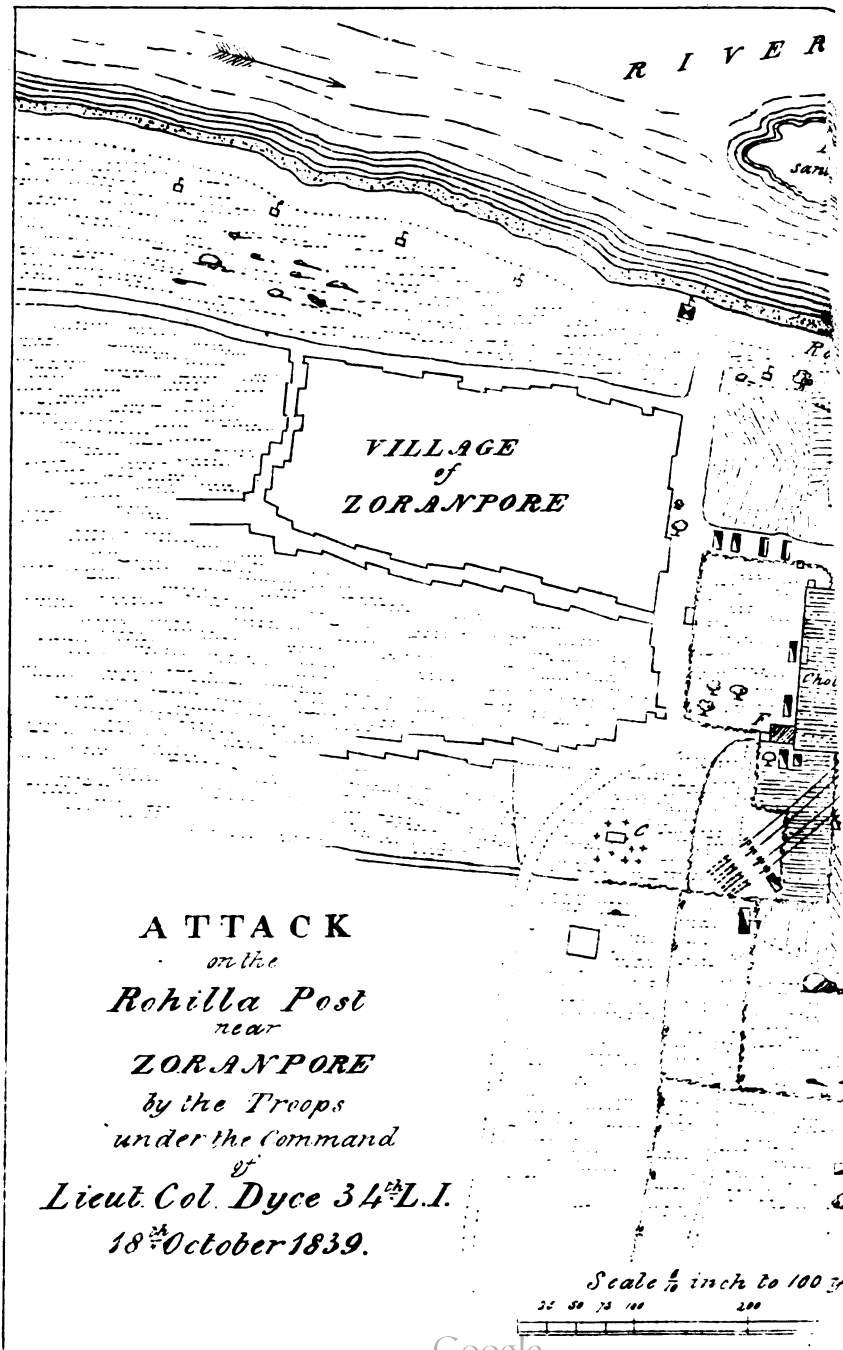
as taken by Lieut.t Kinkead.
of the Madras Artillery.



Digitized by Google

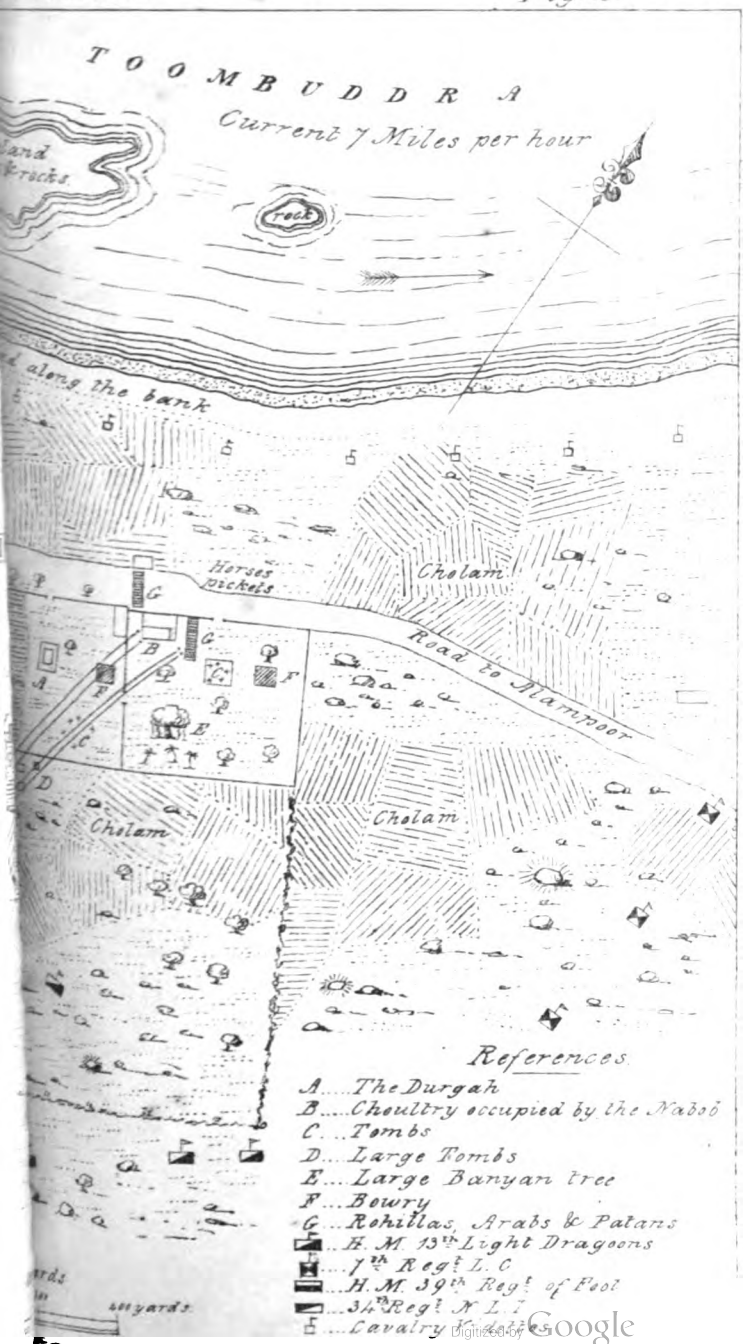
Digitized by Google

Digitized by Google



Digitized by Google

Fig. 2.



Digitized by Google

Digitized by Google

Digitized by Google

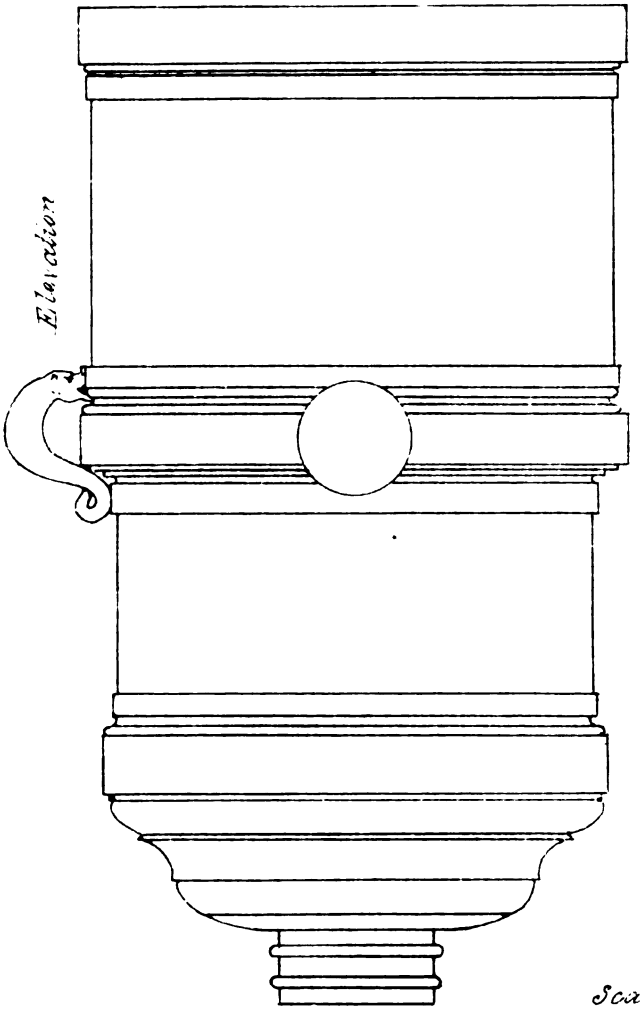
Miscella

Brass Howitzer foun

Approximate weight of Howitzer 5 0 19 lbs. Weight of shell 15 lbs.

Chamber of Howitzer corr

from a drawing by Gunner



Scale 3/4 of an inch

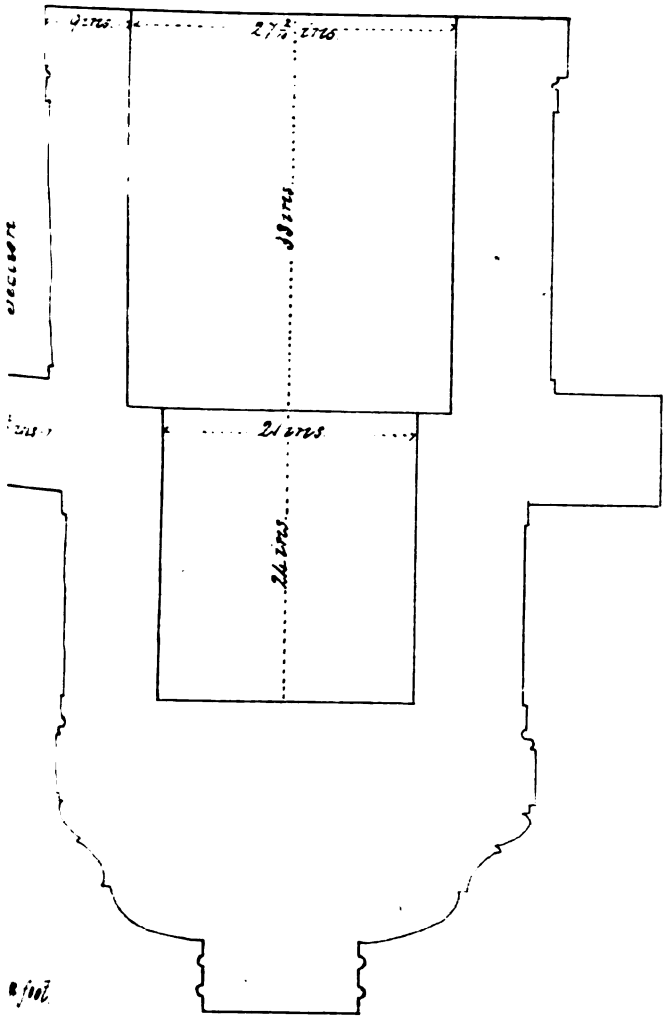
Digitized by Google

us.

fig. 3.

Kurnool 1839.

Internal diam[r] 19 ins. Powder contained in Shell 11 9 lbs.
Ball 2 lbs.
Company 2nd Battn Artly



Digitized by Google

Digitized by Google

Miscellaneous.

fig 4

Large Shell found in Kurnool.

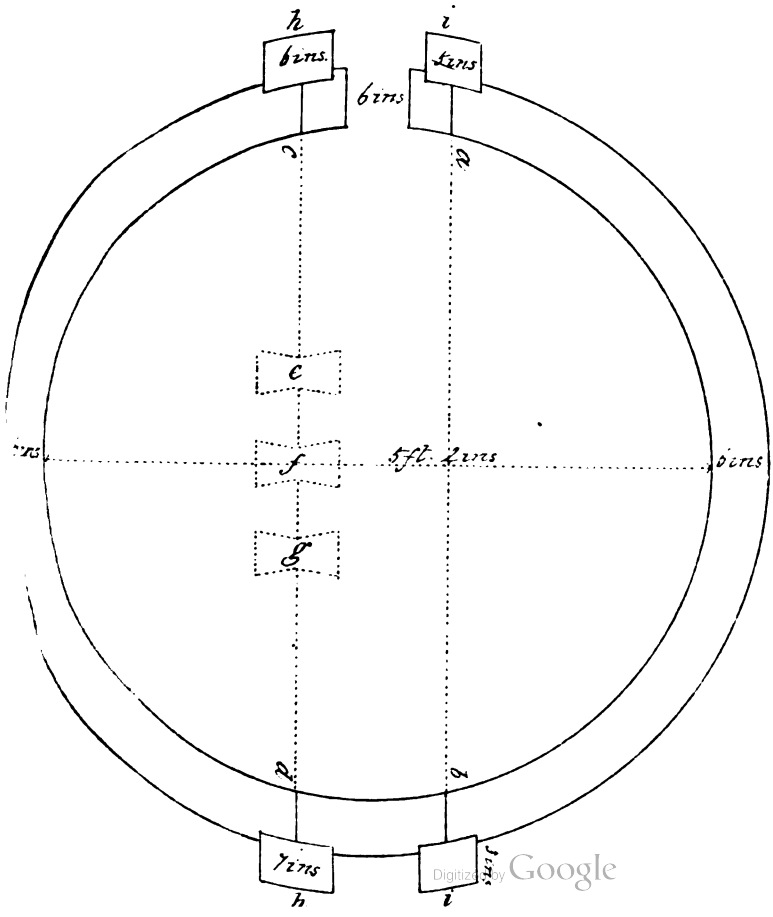
Diameter 6 feet 2 ins.

Cast in three pieces as shewn by the dotted lines a.b.c d

The outer pieces dove-tailed to the center piece e.f.g &

surrounded by two rings h.i.

From a drawing by Gunner J Hill A Comp^{y} 2^{d} Batt^{n} Art^{y}



Digitized by Google

Digitized by Google

Articles.	No.
Hemp uncleaned.....cwt.	6
Saws Cross Cut Country new.....	9
Unkoos, Elephants with Ivory Handles.....	2
Blue Lights.....	A large quantity.
Rockets	
Sunk Pots.....	
Infernal Machines.....	

Abstract of Ordnance found in the Fortress of Kurnool, by the Committee of which Major Bond was President, October 1840.

	Ordnance.			Diameter of Bores.		Length.	
	Mounted.	Dismounted.	Total.	From	To	From	To
				In.	In.	Ft.	Ft.
Howitzers Brass	2	64	133	2.1	27.5	1·	6.18
Howitzers Iron	0	67		2.6	8.7	1·	4.
Mortars Brass	0	3	3	4.25	9.5	2.25	4.
Guns Brass	77	21	161	1.	6.3	1.75	14.
Guns Iron	51	12		2.1	13.3	3.	19.
Ginjals Brass	10	260	285	1·	2.5	1.58	4.5
Ginjals Iron	6	9		1.15	2.5	2.37	15.2
Matchlocks	11	0	11	.9	—	6·	—
Wallpieces	0	7	7	1.8	2·7	4·	4.75
Total	157	443	600				

There were also 4 Brass Guns in the Foundry 8 feet long, apparently 12-pounders, but not finished.

Two of the Brass Guns were 6-pounders, and of English Manufacture.

Of the Brass Ginjals, 5 were mounted on Elephant and 5 on Camel beds; 5 of the Iron Ginjals were also mounted on Camel beds.

Digitized by Google

Memorandum regarding the Disposal of the Stores found at Kurnool.—By Lieutenant BALFOUR.

Major Bond recommended the Gunpowder in quantity lbs. 211,663 to be sent to the nearest stations for the *Exercise* of the Artillery but not for Practice, only in the event of its being found near our "Proof Range." It has however given such wretched ranges, that I am sure it would be a waste of time of carriage expences, to attempt to store it for any other purpose than that proposed, and as it must be removed from the Fort of Kurnool, owing to the dangerous way it is exposed, and it being impossible to apply it to any purpose which would reimburse the expense of the carriage, it would be advisable to throw the whole of it into the river Toombuddra, reserving the fine sporting Dartford and Pigou Gunpowder.

The Saltpetre 857,601 lbs. is of a fair description and would answer well for our Powder Mills. The only enquiry which is requisite is to ascertain the cost of delivery of 1000 lbs. of Saltpetre at Madras, and the cost of carriage of this supply now at Kurnool to Madras. The Sulphur is of the usual fair article of trade, it is certainly advisable to bring this supply down to Madras, it being worth the carriage and of this there are lbs. 273,020.

There are about 100,000 Cloth Cartridges filled with Powder, all these I would recommend to be thrown into the river Toombuddra.

Of the Ordnance, all the Brass ones may be turned to a useful purpose. There are some highly ornamented Guns, Howitzers, and Mortars, all of these can be easily set apart and would be ornamental at the Presidency when neatly mounted. Of the other Pieces they might be sent to Masulipatam "via Innacondah" and there embarked for Calcutta. These Pieces are composed of Zinc, Lead and Copper, in varying proportions, and it will be necessary to separate these metals before the Copper can be brought into use for our Ordnance. This ought to be particularly explained, if sent to Calcutta, lest the same mistake should be made as occurred with the Mahidpore Ordnance. These had like those of Kurnool, a great proportion of Zinc which when exposed to a heavy fire decomposed. I do not think the Iron Guns are worth moving. The cast as well as Iron bar pieces are all large heavy and useless pieces, and if

Digitized by Google

thought necessary their Trunnions might be knocked off or they might be used as anchors in the river for the ferry boats. In the event of any of the Pieces being too heavy to be easily moved, they might be melted up in the furnaces still at Kurnool, or they might be broken which would not be difficult to effect. A large store of firewood would save my expenses for melting the Pieces. The whole of the Ball Cartridges, Musket, should be thrown into the river, reserving the balls as lead. All the Shot, Shells, Grape made of Zinc should be melted up to destroy them, and all Zinc then advertized to be sold at Kurnool, or the metal might be sent to Secunderabad, it is a metal coming into use with the Natives, and being cheaper than Copper, Lead or Tin is in demand. The price which might be obtained for it is about 300 rupees per ton.

The Iron Shot are principally of hammered Iron, those of Cast Iron are useless and would not pay the Carriage expenses, whereas those wrought might be turned to a useful purpose as good Iron, the Cast Iron ones to be destroyed and the others run up into bars. All the fuzes, cotton match and quick match to be burned.

All the Arms, Armour, Pistols, Matchlocks, Spears, Muskets, to be sent to the Presidency, all the Belts, and Pouches to be destroyed. The Flints are of a good quality, and might be distributed to the Arsenals, but they are not so large as our Musket flints. The Copper is in sheets, plates or ingots, and all of an excellent quality and might be turned to a useful purpose at the Mint to which it should be sent. The Iron ore I think might be smelted at Kurnool, and without expense as there is a large supply of firewood. The iron wrought consists of hoops, bars, rods, plates and pieces, and all of a good description.

The whole of it might be distributed to the different Arsenals. Lead is in sheet, of which the greatest quantity is in this form, and the remainder in pigs, all of it of a good quality and English.

The sheet tin is the common article of supply from England packed in cases of, I think 150 in each, and might be distributed to the different Arsenals.

The Steel is in tubs weighing about 150 lbs. each and in small pieces, but all described to be of a good description.

The Zinc might be sold at Kurnool, it is not worth bringing to the coast, where its price would be reduced.

Digitized by Google

The whole of the Laboratory compositions, the rockets, blue lights, stink pots, &c. should be destroyed.

All the empty tin Canisters, and all those at present filled might I think be found useful in working up for our Canister shot.

I think the above notes would be found sufficient to guide any Officer in disposing of the stores, only it is requisite for the safety of the Troops that some decision should be come to, regarding the disposal of the Gunpowder.

Digitized by Google

DIMENSIONS OF MORTARS.

MORTAR. WEIGHT. qrs.	lbs.	LENGTH. feet.	ins.	ths.	DIAM. OF BORE. Vertical ins.	ths.	Horizl. ins.	ths.	Length of Bore. ins.	ths.	Shape.	CHAMBER. Length ins.	ths.	Contents. lb.	oz.	Diameter at entrance. vertl. in.	th	horal. in.	th	Weight of Bed. Cwt.	qrs.	lbs.
1	6	1	8	5	8	0	8	0	8	0	Gomer	8	0	2	4	8	0	8	0	11	0	20
1	4	0	0	0	10	0	10	1	0	0	Conical.	0	0	4	0	5	2	5	2	0	0	0

Rounds.	POWDER. Weight. lbs.	oz.	drs.	Nature and when made.	IRON BALLS. Number.	Weight. lbs.	Diamr. ins.	ths	Elevation. deg.	min	Flight. Sec.	pts.	RANGE. Right. yds.	Left. yds.	DISTANCE. Real. yards.	medium. yards.	Madras S. G. gives with same charge. yards.
1	1	0	0	No. 1 and 2 mixed Powder from Ashreef Khans house, fine.	New ball No. 1.	66·5·12	7	9·5	45	0	0	0	8	0	196		873
2	1	0	0								5	30	7	0	166	179	
3	1	0	0								5	30	5	0	175		
1	0	2	0		No. 2.						2	0	Line		15		
2	0	2	0								2	0	,,		16	17½	
3	0	2	0								2	15	,,		22		
1	0	2	0	No. 3, Powder fine Grain							2	15	Line		23		
2	0	2	0	from Hussain Khan's							2	15	,,		28	25½	
3	0	2	0	house.							2	15	,,		25		
1	0	2	0	No. 4, loose Powder No							1	30	Line		14		

Digitized by Google

Proofs *of Gunpowder received from Kurnool with a fuzil, against mangoe boards, half an inch thick, placed ¾ of an inch in rear of each other. The boards previously soaked in water.*

SAINT THOMAS'S MOUNT.

Date.	Nature of Powder.	Fuzil. Length of Bore.	Fuzil. Diameter of bore.	Ball Diameter	Ball Weight	Distance from target to muzzle of Fuzil.	Charge.	Number of Planks pierced. 1 rd.	2 rd.	3 rd.
		ins.	ins.	ins.	grs.	Feet.	drs.			
28th November 1839.	Nos. 1 and 2. Powder from Ashreef Khan's house Fine.	36·6	·66	·64	276.60	30	4	9	10½	9
	No. 3. Powder fine Grain from Hussain Khan's house.							9	11	9
	No. 4. Loose Powder No. 2 godown No 1 Magazine.							5	5	6½
	No. 5. Powder in cartridge from No. 2 godown No. 1 Magazine.							4	4	5
	No. 6. From chatties from No. 3 Kotah or Godown.							7	6	6

A great number of Sparks were observed at a distance from the mortar after firing; and with No. 6 powder from the Fuzil, sparks were seen to fall at from 15 to 20 feet from the muzzle.

In the proof with the Fuzil, the Steel Ball had to be forced down after the first round with each description of Powder, shewing thereby that the Barrel must have been extremely foul, the Barrel was washed out after the proof of each description of powder.

Digitized by Google

Proof of Gunpowder received from Kurnool, with a PENDULUM EPROUVETTE, *weighing* 3 *qrs.* 4 *lbs. Length* 29 *inches, Diameter of Bore* 1·7 *inches; and length of Pendulum from the centre of the Bore to the point of oscillation* 31·325 *inches.*

SAINT THOMAS'S MOUNT.

Nature of Powder.	Charge.	Vibration. 1 rd.	2 rd.	3 rd.	mean.	
		Degs.	Degs.	Degs.	Degs.	
Nos. 1 and 2 mixed powder from Ashreef Khan's house-fine.	2 oz.	16·45	17·25	17·6	17·5⅓	
No. 3. Powder fine grain from Hussain Khan's house.	0	19·43	18·36	19·44	19·21	
No. 4. Loose powder No. 2 godown No. 1 magazine.	0	16·52	15·41	16·44	16·25⅔	
No. 5. Powder in cartridge, from No. 2 Godown, No. 1 Magazine.	0	16·40	15·51	15·57	16.14	
No. 6 From chatties from No. 3 Kotah or Godown.	0	18·13	19·	17·20	18·11	

Date. 28th November 1838.

APPEARANCE OF THE DIFFERENT POWDERS.

No. 1 & 2. Mixed grains rather smaller than the Madras S. G. and tolerably free from dust.

No. 3. Much smaller than the old Madras S. G. and of a lighter color—free from dust.

No. 4. A mixture of all sized grains and full of dust.

No. 5. A mixture of grains with a smaller quantity of large than No. 4, and full of dust.

No. 6. Same as No. 3.

REMARKS.

No. 1 & 2. The bore and chamber covered with dry scales of residium and several small white spots.

„ 3. The appearance of the bore similar to the above, but in a greater degree.

„ 4. The same appearance as above, the white spots being much larger.

„ 5. Bore very foul with thick dry scales, having a yellow tinge, several flakes adhered to the ball, and were seen to fall off during the flight, with the 2 oz. charge.

„ 6. Bore foul and damp, the residium being quite soft; on spunging the Eprouvette, sulphur was forced up the vent, on the thumb and hand of the man who served the vent.

With the first five powders, the bore had to be frequently scraped with a knife to take off the residium, being so dry, spunging only did not take it off; even with this precaution, force was occasionally used, to get the shell properly into the chamber; with No. 6 powder the bore had to be wiped dry with oakum.

Digitized by Google

PROOF AT BELLARY.

Date.	Ordnance.	No. of Firings.	Powder. Weight. lbs.	oz.	dr.	Nature and when made.	Shell. Weight.	Diamr. ins.	ths.	Elevation. deg.	min.	Flight. sec.	pts.	Range. Right. yds.	Left. yds.	Distance Real. yds.	Medium. yds.
1840																	
Jan. 17		1	2		0							8	0	3	0	230	
" "		2	2		0	*a*						9	0	1	0	248	237
" "		3	2		0							8	30	0	2	233	
" "		4	2		0	*b*						4	30	0	1	63	
" "		5	2		0	*c*						7	0	Line		166	
" 20		6	2		0							11	0	3	0	444	
" "		7	2		0	*d*						12	0	3	0	496	492
" "		8	2		0							12	0	3	0	537	
" 21		9	2		0							17	0	14	0	1100	
" "		10	2		0	*e*						17	0	0	11	1110	1116
" "		11	2		0							18	0	19	0	1140	
" 22		12	2		0	*f*						18	0	19	0	1156	1164
" "		13	2		0							18	30	0	24	1173	
" 23		14	2		0							17	0	0	7	1105	
" "		15	2		0	*g*						18	0	0	7	1153	1120
" "		16	2		0							17	30	40	0	1102	

10 Inch Brass Mortar. Captured at Kurnool, date of Manufacture unknown. 96 lbs. 9 5 45 0

REMARKS.

a. No. 1. C. G. from Shaik Hussain's house, after firing, flakes of Composition adhered to the Bore which could not be removed by sponging and left it very foul.

b. F. G. from Shaik Hussain's house, 1 round only fired, appearance of the Bore after sponging very foul.

c. No. 2. F. G. from Kotah's house—bore as above.

d. From Kotah's house No. 1 Gunpowder, very coarse grain—after firing, the bore became very dirty, composition adhering to it.

e. From Kotah No. 2, Gunpowder L. G. This powder was apparently very little damaged, but after firing more composition adhered to the bore, than in the previous firings.

f. The same powder as on the 3d day, but again dried in the sun, only a sufficient quantity to fire 2 rounds.

g. From Kotah's house No. 1, M. G. No composition adhered to the bore, which was however left rather foul.

Digitized by Google

MEMORANDUM OF EXPERIMENTS WITH TEAK TIMBER, FROM ALLEPPY, TRAVANCORE, PONANY, AND CALICUT.

Fig. 5.

Date.	Where From	Ship came in.	Weight Broke with lbs.	
1833				
April 20	Alleppy	Argyle.	628	Bad quality, short waved curly grain.
22	do.	do.	893	
27	do.	do.	795½	
	do.	Trivettore	823⅔	
	do.	Argyle	832⅓	
	do.	Malcolm.	730	
	do.	do.	720⅔	
	do.	McNaughten	804⅓	
	do.	do.	814	
1834	do.	Malcolm	814	
Octbr. 28	do.	Argyle	1075⅓	
" 29	do.	Malcolm	870	Not a good selection.
	do.	Trivettore	852	do. do.
	do.	Brig two Brothers..	907½	A good piece of Timber but the supply is not generally of this quality.
Decr. 10	Travancore.	do.	982	Fibrous.
	do.	do.	478	This piece of poor quality and not according to the general run of the Timber.
	do.	do.	907½	Fibrous.
Special Selection.	Alleppy	Argyle	1075⅓	These pieces well seasoned, dry, fibrous, and of good quality.
"	Travancore.	McNaughten	944⅔	Cross grained, free from pith, and splintered up the grain when breaking.
" 23	do.	Argyle	888⅔	do. do. do.
"	do.	Trivettore	1038	Straight grained, free from pith, splintered right and left in breaking.
1835	Alleppy	Drongan	870	Fibrous.
April 7	do.	do.	814	do.
	do.	do.	814	do.
	Ponany	Drongan	814	Straight grained, rather pithy, broke short off.
	do.	do.	870	Very Similar.
	do.	do.	646	do.
	Calicut	do.	888⅔	Straight grained, fibrous, free from pith, splintered up the grain in breaking.
	do.	do.	944⅔	do. do. do. good.
	do.	do.	907½	do. do. do.

Digitized by Google

Memorandum of Experiments, &c. continued

Date.	Where From.	Ship came in.	Weight broke with lbs.	REMARKS.
1836				
June 28	Alleppy	Nerbuddah	664⅔	
	do.	do.	702	
	do.	do.	720⅔	
30	do.	Drongan	870	
	Ponany	do.	627⅓	
	Calicut	do.	832⅔	
	do.	do.	814	
July 1	Alleppy	do.	462	
	do.	do.	758	
	do.	Nerbuddah	907⅓	
	do.	Drongan	974	
	Ponany	do.	720⅔	
	do.	do.	758	
1837	Calicut	do.	758	
March 7	Alleppy	do.	814	
	do.	do.	926	
	do.	do.	814	
	do.	do.	926	
	do.	do.	926	
	do.	do.	926	
	do.	do.	814	
	do.	do.	926	
	do.	do.	1038	
1838	Calicut	Barque Ruparell	926	
Oct. 16	do.	do.	1150	
	do.	do.	1038	
	do.	do.	926	
	do.	do.	926	
	do.	do.	926	
	do.	do.	814	
	do.	do.	1150	
	do.	do.	1262	

(Signed) J. H. FRITH,
Lieutenant Colonel.

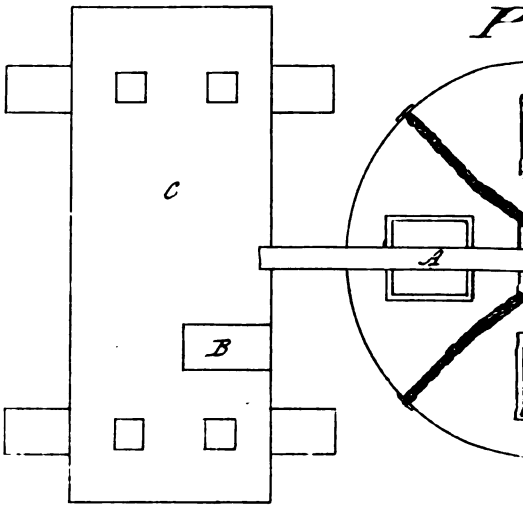
Digitized by Google

Digitized by Google

Miscell

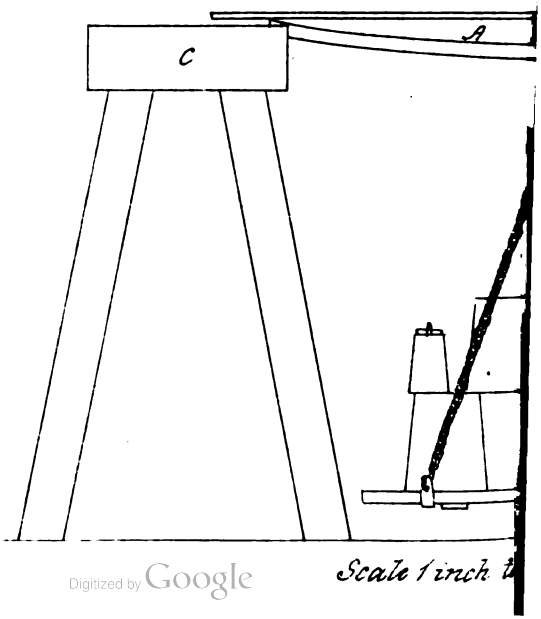
Stand for breaking E

P



Note - The scale being suspended from the center of the piece of wood eight ½ cwts are put on, & the bend shewing the stiffness of the wood taken with the levelling rod & sliding scale as shewn in the sketch: two more weights are then added, & the bend noted as before, & again two more in the same way & the bend taken: after which the weights are laid on singly, & with great care till the wood breaks.
When the timber begins to bend, 5 minutes should be allowed to elapse before fresh weights are added, & so continued till the timber breaks.

Elev



Scale 1 inch t

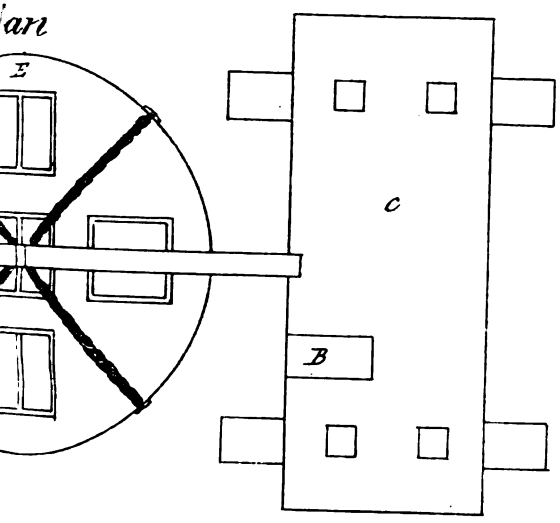
Digitized by Google

aneous.

xperimental Timber.

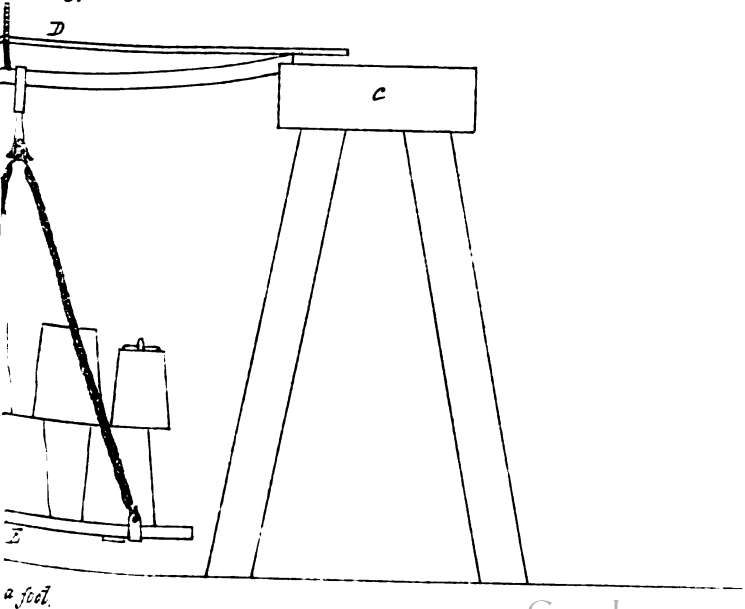
fig. 5.

lan



A. Experimental timber 3 feet long & 1½ inch squar
BB. Openings to break barn boos or round timber
CC. Benches
D. Levelling rod to shew the bending of the timbe
E. Scale & weights

ation.



a foot.

Digitized by Google

Digitized by Google

Digitized by Google

Misc

Large Gun laid to rake

from a drawing by Gunn

Length of 6

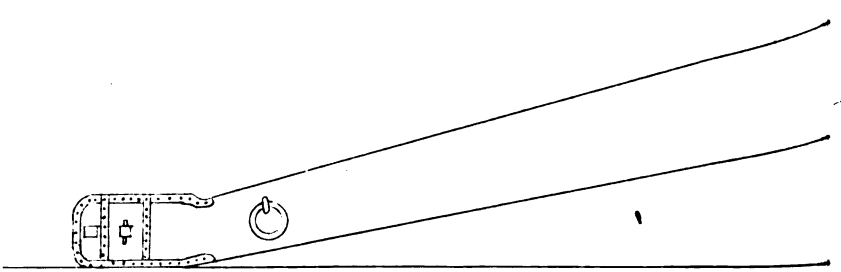
.....6

Diameter of

.....

.....

Weight of a



Scal

Digitized by Google

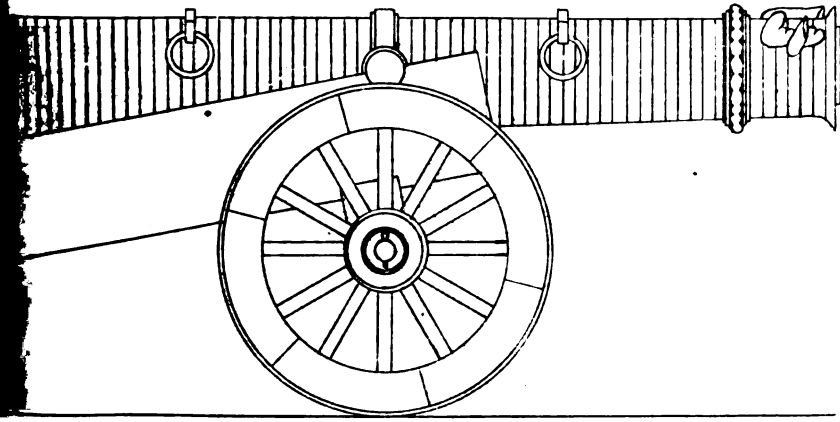
ous.

fig: 6.

ain Street of Kurnool Fort.

Company 2nd Batt.n Artillery

ft. ins.
19 . 1
29 . 10
. -
. 1½
1 . -½
43 lbs.



to a foot.

Digitized by Google

Digitized by Google

EXPERIMENTS ON THE STRENGTH OF THE UNDERMENTIONED SPECIMENS OF TIMBER.

Date.	No. marked on Timber.	No. of pieces broke	Nature of Wood.	Length		Dimension square.	Specimen. Weight			Bent with.			Broke with lbs. including scale, 30lbs.	Average weight broke with.	REMARKS.	
				feet.	inches.		lbs.	oz.	drs.	8 half cwt.	10 half cwt.	12 half cwt.		lbs.		
						In				Ins.	Ins.	Ins.				
16th October 1838.	0	1	Saul, cut out of an old traversing handspike from a Bengal Carriage	3	0	1½	2	1	10	·70	·80	·90	1150	1094	Broke 2 minutes after the 20th weight.	In breaking shew'd strong Grain close and adhesive qualities, grain fibrous.
		2	" " "	3	0	1½	2	3	13	·70	·90	1·10	1038		Cracked 3 minutes after the 16th weight and broke 1 minute after the 18th weight.	
	C66	1	Bark Ruparell, Calicut	3	0	1½	2	7	1	·60	·70	·90	926		Broke 4 minutes after the 16th weight.	
	.78	2	teak timber from log 16	3	0	1½	2	7	7	·60	·75	·80	1150	1038	" 1 " " 20th "	
		3	ft. long 20 by 16 inches	3	0	1½	2	8	3	·60	·80	1·0	1038		" 4 " " 18th "	
	52	1	" " " from a log	3	0	1½	2	5	4	·70	·90	1·20	926		" 2 " " 16th "	close and fibrous.
	C.67	2	26 feet long 28 by 13	3	0	1½	2	9	0	·60	·75	1·0	926	926	" 2 " " 16th "	
		3	inches.	3	0	1½	2	6	15	·65	·80	1·10	926		" 1 " " 16th "	
		1	" " " from a	3	0	1½	2	1	15	·60	1·0	1·30	814		" 3 " " 14th "	
	C.27	2	log 33¼ feet long 20 by	3	0	1½	2	5	5	·50	·60	·70	1150	1075⅓	" 1½ " " 20th "	
		3	20 inches.	3	0	1½	2	6	6	·50	·60	·70	1262		Cracked 4 " " 20th " and broke ½ minute after 22d weight.	
			Tenasserim Teak Timber purchased in Madras Market in September 1838.													

Digitized by Google

EXPERIMENTS ON THE STRENGTH OF TIMBER, continued.

Date.	No. marked on Timber	No. of pieces broke.	Nature of Wood.	Length. feet.	Length. ins.	Dimensions Square.	Specimen. Weight. lbs.	Specimen. Weight. oz.	Specimen. Weight. drs.	Bent with 8 half cwt.	Bent with 10 half cwt.	Bent with 12 half cwt.	Broke with lbs. including scale 30 lbs.	Average weight broke with. lbs.	REMARKS.
1838						in.				ins.	ins.	ins			
Oct. 20	14	1	From a log 16 feet	3	0	1½	2	10	4	·60	·70	·95	814		Cracked immediately with 14 weights and broke ¾ minute afterwards.
	14	2		3	0	1½	2	8	5	·60	·80	1·40	814		Broke ½ a minute after the 14th weight.
	14	3	long 17 by 10½ ins.	3	0	1½	2	11	3	·60	·75	1·10	814	814	Cracked immediately with 14 weights and broke ½ minute afterwards.
	15	1		3	0	1½	2	5	13	·50	·70	·95	926		Broke ½ a minute after the 16th weight.
	15	2	From a log 17½ feet	3	0	1½	2	6	15	·60	·80	1·30	814		,, 1 ,, ,, 14th ,,
	15	3	long, 17½ by 13½ ins.	3	0	1½	2	6	10	·50	·70	1·0	814	851⅓	Cracked in 2 minutes with 14 weights and broke ½ a minute afterwards.
	20	1		3	0	1½	2	7	9	·50	·70	1·0	814		Cracked 1 minute after the 14th weight and broke 1¾ minutes afterwards.
	20	2	From a log 19 feet	3	0	1½	2	0	0	60	·90	...	702		Broke ½ a minute after the 12th weight
	20	3	long, 16¼ by 16¼ ins.	3	0	1½	1	13	4	·50	·80	...	702	739⅓	,, ½ ,, ,, 12th ,,
Nov. 9		1		3	0	1½	2	2	12	·65	·85	1·50	814		,, ½ ,, ,, 14th ,,
		2	Seringapatam Teak	3	0	1½	2	1	3	·75	1·0		702		,, 1½ ,, ,, 12th ,,
		3	Timber, cut out of an	3	0	1½	2	2	9	·65	·80		702	739⅓	,, 1 ,, ,, 12th ,,
		1	old 18 pdr. carriage	3	0	1½	2	3	2	·65	·85		702		,, ½ ,, ,, 12th ,,
,, 16		2	cheek built in 1807,	3	0	1½	2	0	13	·85	1·10		702		,, 1 ,, ,, 12th ,,
		3	No. 6, (Col. Scott's)	3	0	1½	2	1	13	·75	·90		646	683⅓	,, ½ ,, ,, 11th ,,

Inferior, cracked across, without splintering.

GUN CARRIAGE MANUFACTORY:
MADRAS, 16th *November* 1838.

(Signed) J. H. FRITH, Lieut.-Colonel,
Prin. Comy. of Ord. & Supt. Gun Carriage Manufactory.

Digitized by Google

EXPERIMENTS ON THE STRENGTH OF THE UNDERMENTIONED SPECIMENS OF TIMBER FROM THE FORESTS OF CANARA.

Date.	Yard No.	No. of Specimen.	Nature of Wood.	Length. feet.	Length. ins.	Dimensions square. in.	Specimens. Weight. lbs.	oz.	drs.	Bent with 8 half cwt. ins.	Bent with 10 half cwt. ins.	Bent with 12 half cwt. ins.	Broke with lbs. including scales 30 lbs.	Average weight broke with lbs.	REMARKS.	
1840 May 20	1	1	Bitty or Rose Wood.....	3	0	1½	2	6	2	·55	·7	·9	926	870	Cracked in 4 minutes with 14 weights and broke in 3 minutes with the 16th. „ 3 „ 16 „ 2 „ 17th. Broke with 12 weights in 1½ minutes	Would be useful for any work according to its size & fellies executed.
	1	2		3	0	1½	2	9	10	·65	·8	1·5	982			
	1	3		3	0	1½	2	4	11	·8	1·1	1·4	702			
	2	1	Nundy.	3	0	1½	2	1	15	1·1	2·5	0	590	552⅔	Broke in ½ a minute with 10 weights „ ½ „ 10 „ „ ½ „ 8 „	Fit for spokes.
	2	2		3	0	1½	2	1	15	1·4	3·	0	590			
	2	3		3	0	1½	2	6	4	4·	0	0	478			
	3	1	Myroll.....	3	0	1½	3	3	7	·75	1·	0	590	664⅔	„ 1 „ 10 „ „ ½ „ 12 „ „ 2 „ 12 „	Of no use.
	3	2		3	0	1½	3	4	2	·7	·9	1.3	702			
	3	3		3	0	1½	3	2	5	·65	·85	1 2	702			

Digitized by Google

EXPERIMENTS ON THE STRENGTH OF TIMBER, continued.

Date.	Yard No.	No. of Specimen.	Nature of Wood.	Length. feet.	Length. ins.	Dimensions square.	Specimen. Weight. lbs.	Specimen. Weight. oz.	Specimen. Weight. drs.	Bent with 8 half cwt.	Bent with 10 half cwt.	Bent with 12 half cwt.	Broke with lbs. including scale 30 lbs.	Average weight broke with lbs.	REMARKS.
1840						in.				inch	inch	inch			
May 20	4	1	Theroopoo....	3	0	1½	3	4	8	·4	·55	·65	1038	1038	Cracked in 1½ minute with 16 weights and broke in ½ minute with the 18th. Broke in ½ a minute with 18 weights. Cracked in 3 minutes with 16 weights & broke in 2½ minutes with the 18th — Apparently would do for any work, fellies excepted.
	4	2		3	0	1½	3	1	13	·45	·55	·65	1038		
	4	3		3	0	1½	3	2	15	·4	·5	·65	1038		
	5	1	Muthee	3	0	1½	2	6	14	·85	1·6	2·8	702	702	Broke in 3 minutes with 12 weights; " 2 " 12 "; " 2 " 12 " — Fit for spokes handspikes limberpoles splinterbars yokes, &c.
	5	2		3	0	1½	2	9	6	·95	1·6	2·5	702		
	5	3		3	0	1½	2	7	11	1·	1·4	2·	702		
	6	1	Pela	3	0	1½	3	0	9	·6	·8	1·1	814	888⅔	" 3½ " 14 "; " 1½ " 16 "; Cracked in 2½ mins. with 16 weights and broke in 2 minutes afterwards. — Fit for most other works but cheeks and fellies,
	6	2		3	0	1½	3	5	8	·5	·75	1·	926		
	6	3		3	0	1½	2	15	10	·6	·75	1·	926		

GUN CARRIAGE MANUFACTORY:
MADRAS, 22*d May* 1840.

(Signed) F. BOND, Major,
Actg. P. C. O. & S. G. C. M.

Digitized by Google

ORDNANCE DRAUGHT.

SCALE *of* **CATTLE** *to be attached to the undermentioned Ordnance Carriages and Carts on Service, and proceeding from one Station to another, agreeable to G. O. G. dated 8th September* 1840.

IN THE FIELD.

NATURE OF ORDNANCE AND CARRIAGES.		In Yoke.	Spare.	Total.	Weight of Ordnance.	Carriage & Limber.	Ammunition or Load.	Total.	Proportion per Bullock
IRON ORDNANCE.									
Gun with Carriage and Limber	24-Pounder	46	12	58	5,600	4,704	....	10,304	224
Gun on Transport Carriage	24 „	42	8	50	5,600	3,276	....	8,876	$211\frac{1}{2}$
Carriage without the Gun	24 „	22	4	26	..	4,704	....	4,704	$213\frac{2}{11}$
Gun with Carriage and Limber	18 „	42	8	50	4,816	4,512	....	9,328	$222\frac{2}{21}$
Gun on Transport Carriage	18 „	38	7	45	4,816	3,276	....	8,092	$212\frac{1}{19}$
Carriage without the Gun	18 „	18	4	22	..	4,512	....	4,512	$250\frac{2}{3}$
Gun with Carriage and Limber	12 „	34	6	40	3,920	4,200	....	8,120	$235\frac{5}{17}$
Gun on Transport Carriage	12 „	30	6	36	3,920	3,276	....	7,196	$239\frac{1}{15}$
Carriage without the Gun	12 „	14	3	17	..	4,200	....	4,200	300
Howitzer with Carriage and Limber ..	10-Inch.	46	12	58	4,454	5,712	....	10,166	221
„ Carriage without the Gun	10 „	24	4	28	..	5,712	....	5,712	238
„ with Carriage and Limber ..	8 „	26	6	32	2,341	4,816	....	7,157	$275\frac{7}{13}$
„ Carriage without the Gun ..	8 „	18	3	21	..	4,816	....	4,816	$267\frac{1}{18}$

Digitized by Google

NATURE OF ORDNANCE AND CARRIAGES.	In Yoke.	Spare.	Total.	Weight of Ordnance.	Weight of Carriage & Limber.	Weight of Ammunition or Load.	Weight of Total.	Proportion per Bullock
BRASS ORDNANCE.								
Gun with Carriage and Limber 9-Pounder	10	2	12	1,008	2,464	448	3,920	392
Carriage without the Gun .... 9 „	6	1	7	..	2,464	..	2,464	410 2/3
Gun with Carriage and Limber .... 6 „	8	2	10	672	2,436	461	3,569	446 1/8
Carriage without the Gun .... 6 „	6	1	7	..	2,436	..	2,436	406
Gun with Carriage and Limber .... 3 „	4	1	5	336	800	230	1,366	341 1/2
Carriage without the Gun .... 3 „	2	1	3	..	800	..	800	400
Howitzer with Carriage and Limber .. 12 „	8	2	10	738	2,520	408	3,666	458 1/4
„ Carriage without the Gun .. 12 „	6	1	7	..	2,520	..	2,520	420
„ with Carriage and Limber .. 24 „	10	2	12	1,120	2,668	432	4,220	422
„ Carriage without the Gun .. 24 „	6	1	7	..	2,668	..	2,668	444 1/3
Cart with Brass Mortar and Bed, one 10-Inch.	10	2	12	1,344	1,876	..	3,220	322
„ without Bed ..... „ 10 „	4	1	5	1,344	..	..	1,344	336
„ with Bed ..... two 8 „	8	2	10	1,360	2,200	..	3,560	445
„ without Bed ..... „ 8 „	4	1	5	1,360	....	..	1,360	340
„ with Bed ..... four 5 1/2 „	8	2	10	784	1,792	..	2,576	322
Mortar Cart, spare.....	6	0	6	..	..	..	1,988	331 1/6
Ammunition Waggon for Horse Artillery laden	8	2	10	1,122	2,474	..	3,596	449 1/8
„ „ ....empty	6	1	7	..	2,474	..	2,474	412 1/3

Digitized by Google

Ammunition Cart for Foot Artillery	laden	4	1	5	650	1,148	.....	1,798	449½
,, ,, ...	empty	2	1	3	..	1,148	.....	1,148	574
Transport Carriage, spare.....		12	2	14	..	..	.....	3,276	273
Forge Cart	laden	6	2	8	..	..	.....	1,800	300
,, ...	empty	4	1	5	..	..	.....	1,300	325
Artificer's Cart	laden	6	2	8	..	..	.....	1,700	283⅓
,, ...	empty	4	1	5	..	..	.....	1,200	300
Mortar Cart with Gin complete.....		8	2	10	..	..	.....	3,368	421
Mortar Cart with Mortar Platform.....		8	1	9	..	..	.....	2,888	361
Mortar Cart with Gun Platform.....		8	2	10	..	..	.....	3,238	404⅝
Forge or Artificer's Waggon	empty	8	0	8	..	..	.....	2,604	325½
,, ,, ...	laden	8	2	10	..	..	.....	3,104	388
Store Waggon	empty	6	2	8	..	..	.....	2,492	415⅓
,, ...	laden	8	2	10	..	..	.....	2,992	374
Cart Platform with 800lbs.....		4	0	4	..	..	.....	1,472	368
,, ,, with 1,200lbs....		6	0	6	..	..	.....	1,872	312
Cart Mortar with 1 Iron Mortar and Bed	10-Inch.	18	3	21	1,832	2,408	.....	6,228	346
,, with 1 Mortar	10 ,,	12	2	14	1,832	..	.....	3,820	318⅓
,, with 1 Bed	10 ,,	14	2	16	..	2,408	.....	4,396	314
,, with 2 Iron Mortars and Beds	8 ,,	18	3	21	1,904	2,520	.....	6.412	356⅔
,, with 2 Mortars	8 ,,	12	2	14	1,904	..	.....	3,892	324⅓
,, with 2 Beds	8 ,,	14	2	16	..	2,520	.....	4,508	322
,, with 4 Brass Mortars and Beds	5½ ,,	14	2	16	784	1,792	.....	4,564	326
,, with 4 Mortars	5½ ,,	8	2	10	784	..	.....	2.772	346½
,, with 4 Beds	5½ ,,	10	2	12	—	1,792	.....	3,780	378

Digitized by Google

NATURE OF ORDNANCE AND CARRIAGES.	In Yoke.	Spare.	Total.	Weight of Ordnance.	Weight of Carriage & Limber.	Weight of Ammunition or Load.	Weight of Total.	Proportion per Bullock
OBSOLETE ORDNANCE BUT STILL USED OCCASIONALLY.								
Gun with Carriage and Limber 12-Pounder	12	2	14	1,344	3,080	.....	4,424	368¾
Carriage without the Gun ..... 12 „	8	1	9	..	3,080	.....	3,080	385
Howitzer with Carriage and Limber .. 8-Inch.	18	2	20	1,540	3,900	.....	5,440	302⅔
Carriage without the Gun ..... 8 „	10	2	12	..	3,900	.....	3,900	390
Howitzer with Carriage and Limber, heavy 5⅘ „	12	2	14	1,092	3,164	.....	4,256	354 $\frac{8}{14}$
Carriage without the Gun ..... „ 5⅘ „	8	2	10	..	3,164	.....	3,164	395⅘
Carriage and Limber, medium .... 5½ „	10	2	12	784	2,528	.....	3,312	331
Carriage without the Gun ..... 5½ „	6	1	7	..	2,528	.....	2,528	421⅜
IRON ORDNANCE.				FROM STATION TO STATION				
Gun with Carriage and Limber 24-Pounder	38	6	44	5,600	4,704	.....	10,304	271 $\frac{3}{19}$
Gun on Transport Carriage .... 24 „	34	4	38	5,600	3,276	.....	8,876	261 $\frac{1}{17}$
Carriage without the Gun .... 24 „	14	4	18	..	4,704	.....	4,704	336
Gun with Carriage and Limber .... 18 „	30	6	36	4,816	4,512	.....	9,328	310 $\frac{4}{15}$
Gun on Transport Carriage .... 18 „	30	4	34	4,816	3,276	.....	8,692	289 $\frac{1}{5}$
Carriage without the Gun ..... 18 „	14	4	18	..	4,512	.....	4,512	322⅔
Gun with Carriage and Limber .. 12 „	26	4	30	3,920	4,200	.....	8,120	312 $\frac{4}{13}$
Gun on Transport Carriage .... 12 „	22	4	26	3,920	3,276	.....	7,196	327 $\frac{1}{11}$

Digitized by Google

[illegible] without the Gun	12 „	12	2	14	..	4,200	....	4,200	350
[illegible] with Carriage and Limber	10-Inch.	38	6	44	4,454	5,712	....	10,166	267$\frac{8}{9}$
[illegible] Carriage without the Gun	10 „	16	4	20	..	5,712	....	5,712	357
[illegible] with Carriage and Limber	8 „	18	4	22	2,341	4,816	....	7,157	397$\frac{1}{9}$
Howitzer Carriage without the Gun ..	8 „	14	2	16	..	4,816	....	4,816	344
BRASS ORDNANCE.									
Gun with Carriage and Limber	9-Pounder	8	2	10	1,008	2,464	....	3,472	434
Carriage without the Gun	9 „	6	0	6	..	2,464	....	2,464	410$\frac{1}{3}$
Gun with Carriage and Limber	6 „	8	0	8	672	2,436	....	3,208	401
Carriage without the Gun	6 „	6	0	6	..	2,436	....	2,436	406
Gun with Carriage and Limber	3 „	4	0	4	336	800	....	1,136	284
Carriage without the Gun	3 „	2	0	2	..	800	....	800	400
Howitzer with Carriage and Limber ..	12 „	8	0	8	738	2,520	....	3,258	407$\frac{1}{4}$
Howitzer Carriage without the Gun ..	12 „	6	0	6	..	2,520	....	2,520	420
Howitzer with Carriage and Limber	24 „	10	2	12	620	2,668	....	3,288	328$\frac{8}{10}$
Howitzer Carriage without the Gun ..	24 „	6	0	6	..	2,668	....	2,668	444$\frac{4}{6}$
Cart with Brass Mortar and Bed, one	10-Inch.	8	2	10	1,344	1,876	....	3,220	402$\frac{1}{6}$
Cart without Bed ..... „	10 „	4	0	4	1,344	..	....	1,344	336
Cart with Bed ..... two	8 „	8	0	8	1,360	2,220	....	3,56[illegible]	445
Cart without Bed ..... „	8 „	4	0	4	1,360		....	1,360	340
Cart with Bed ..... four	5$\frac{1}{2}$ „	8	0	8	784	1,792	....	2,576	322
Mortar Cart Spare.....		4	1	5	..	..	....	1,988	497
Ammunition Waggon for Horse Artillery	laden	8	0	8	1,120	2,389	....	3,509	438$\frac{3}{8}$
Ammunition Waggon for Horse Artillery	empty	6	0	6	..	2,389	....	2,389	398$\frac{1}{6}$
Ammunition Cart for Foot Artillery	laden	4	0	4	600	1,148	....	1,748	437
Ammunition Cart for Foot Artillery	empty	2	1	3	..	1,148	...	1,148	574

Digitized by Google

NATURE OF ORDNANCE AND CARRIAGES.	In Yoke.	Spare.	Total.	Weight of Ordnance.	Weight of Carriage & Limbers.	Weight of Ammunition or Load.	Weight of Total.	Proportion per Bullock
Transport Carriage Spare	10	2	12	..	..	....	3,276	327 6/10
Forge Cart .... laden	6	0	6	..	..	....	1,800	300
Forge Cart .... empty	4	0	4	..	..	....	1,300	325
Artificers Cart .... laden	6	0	6	..	..	....	1,700	283 3/6
Artificers Cart .... empty	4	0	4	..	..	....	1,200	300
Mortar Cart with Gin complete	8	0	8	..	..	....	3,368	421
Mortar Cart with Mortar Platform	6	1	7	..	..	....	2,888	481 3/6
Mortar Cart with Gun Platform	8	0	8	..	..	....	3,238	404 1/4
Forge or Artificers Waggon .... empty	6	1	7	..	..	....	2,604	434
Forge or Artificers Waggon ..... laden	8	0	8	..	..	....	3,104	388
Store Waggon .... empty	6	0	6	..	..	....	2,492	415 1/3
Store Waggon .... laden	8	0	8	..	..	....	2,992	374
Cart Platform with 800lbs	4	0	4	..	..	....	1,472	368
Cart Platform with 1,200lbs	6	0	6	..	..	....	1,872	312
Cart Mortar with 1 Iron Mortar and Bed....10-Inch.	16	2	18	1,832	2,408	....	6,228	389 1/4
Cart Mortar with 1 Mortar .... 10 „	10	1	11	1,832	..	....	3,820	382
Cart Mortar with 1 Bed ..... 10 „	10	1	11	..	2,408	....	4,396	439 6/10
Cart Mortar with 2 Iron Mortars and Beds 8 „	16	2	18	1,904	2,520	....	6,412	400 1/4
Cart Mortar with 2 Mortars ..... 8 „	10	1	11	1,984	..	....	3,892	389 1/3
Cart Mortar with 2 Beds ..... 8 „	10	1	11	..	2,520	....	4,308	430 1/5

Digitized by Google

Cart Mortar with 4 Brass Mortars and Beds	5⅘ „	10	1	11	784	1,792	....	4,564	456⅘
Cart Mortar with 4 Mortars	5⅘ „	8	0	8	784	..	....	2,772	346⅘
Cart Mortar with 4 Beds	5⅘ „	8	1	9	..	1,792	....	3,780	472⅕
OBSOLETE ORDNANCE BUT STILL USED OCCASIONALLY.									
Gun with Carriage and Limber	12-Pounder	12	0	12	1,344	3,080	....	4,424	368⅓
Carriage without the Gun	12 „	8	0	8	..	3,080	....	3,080	513⅓
Howitzer with Carriage and Limber ..	8-Inch.	16	2	18	1,540	3,900	....	5,440	340
Carriage without the Gun	8 „	10	0	10	..	3,900	....	3,900	390
Howitzer Heavy with Carriage and Limber	5½ „	10	2	12	1,092	3,164	....	4,256	425½
Howitzer Carriage without the Gun ..	5½ „	8	0	8	..	3,164	....	3,164	395½
Howitzer Carriage and Limber, medium	5½ „	8	2	10	784	2,528	....	3,312	414
Howitzer Carriage without the Gun ..	5½ „	6	0	6	..	2,528	....	2,528	421⅕

Digitized by Google

Digitized by Google

DAMPIER'S PATENT GEOMETRIC BALANCE.

Of the many devices for the purpose of weighing letters, this ingenious machine is decidedly the most elegant, and the most practically useful. It combines the advantages of durability, simplicity and the most accurate precision. The principle of the construction of the Geometric Balance being purely mathematical, it is applicable to the minutest as well as the most bulky packets. In the ordinary scale a number of weights are required, whilst in this a single weight alone is necessary; a bronze hand and dial indicating the exact weight, so soon as the matter to be weighed is placed in the scale. The sample now before us forms an elegant ornament to the drawing-room table, and besides indicating the weight of a letter or package, from half an ounce to 8 ounces included, explains the post-office charge for each successive weight. We never met with a balance more simply and yet ingeniously constructed.

WORDS OF COMMAND FOR PRIMING, LOADING, AND FIRING IN CROMWELS'S TIME, VIZ. 1649.

1st. Balance your Musket in left hand.
2d. Find your Charge.
3rd. Open your Charge.
4th. Charge with Bullet.
5th. Put your scouring stick in your musket (ramrod).
6th. Run home your Charge.
7th. Draw forth your scouring Stick.
8th. Turn and shorten him to a handful.
9th. Return your scouring Stick.
10th. Bring forward your musket and poize.
11th. Balance your musket in left hand, barrel upwards.
12th. Draw forth your match.
13th. Blow the ashes from your coal.
14th. Present upon your left hand.
15th. Give fire breast high.

BOMBARDIERS OF ROYAL ARTILLERY.

G. O. August 15th 1840.—The Master General has great pleasure in promulgating the following General Order to the Royal Regiment of Artillery.

(Signed) J. E. JONES, *A. A. General.*

No. 546.—General Order, Horse Guards, July 29th 1840. Her Majesty has been graciously pleased to command,

Digitized by Google

that Bombardiers of the Royal Artillery will rank as Corporals, by Command of the Right Hon. General Lord Hill, Commanding-in-Chief.

(Signed) J. MACDONALD, *Adjutant General.*

NEW MUSKET FOR THE BRITISH ARMY.

About 4 weeks ago the Master General of the Ordnance, Sir Hussey Vivian, issued instructions that 2 muskets, on an entirely new principle, which had been submitted to him by a London manufacturer, should have a fair trial. The muskets were accordingly forwarded to Woolwich, and placed in the charge of an intelligent Corporal, with orders that 1,000 rounds of ball Cartridge should be fired from each, for the purpose of testing their capabilities and ascertaining their good or bad qualities. The Corporal selected 2 experienced gunners, and the men have attended every day at the Butt in the Royal Arsenal to practice with them. The trials of the muskets have now been completed, and the ease, rapidity, and precision with which they can be used, has afforded the greatest satisfaction, and even surprise, on account of the simplicity of their construction. On Friday they had to endure a severe trial, 100 rounds having been fired as fast as the men could load, at the rate of about 10 shots in 4 minutes, and although the barrel became quite warm, the men did not apprehend any danger, and none took place. This was singular, as 100 rounds was rather a bold experiment without cleaning. The barrel of this musket is of the same length and thickness as those used by the soldiers of the line at present; the only difference is, that the touchhole instead of being placed at the side is under the stock, immediately in front of the trigger, which is secured from the possibility of discharging the musket by accident, even under the most careless circumstances. Instead of flints, percussion caps are used, and the force necessary to ignite them is effected by a steel spring, about 7 inches in length, and so simple that it can scarcely ever get out of order. Owing to the construction of the lock of the present musket, the stock is much weakened by having to cut out a portion for its reception, and 20 screws are required to fix the various parts to each other and to the barrel. By the new plan, which is secured by patent, five screws only are required, and there is no cutting requisite for adjusting it to the stock and barrel. When the 1,000 rounds have all been fired from the muskets a report will be given in to the Master General, and there is every probability that they will be

Digitized by Google

adopted without delay. It is stated that the East India Company have already given a large order for this pattern musket, to supply a portion of the troops under their control.

TRIAL OF THE NEW PERCUSSION LOCK.

A trial recently took place at Quebec on the ball cartridge mound on the west front of the citadel, of the comparative merits of the ordinary flint and steel lock, in general use in the Army, and the percussion lock, with which the musket of the Coldstream Regiment of Guards are provided. The number of muskets of each lock were equal, and the shots put into the target by the percussion locks were, if we are correctly informed, as two to one above the flint and steel. Upwards of 30 shots from the flint locks missed fire during the three rounds, whilst from the locks of the Coldstream only one miss-fire, occurred, and that was from a defective mainspring. The superiority of the percussion lock, under ordinary circumstances, may be considered as fairly established. After the musketry competition had taken place, an experiment was made of the modern method of blowing open gates, without having recourse to the petard. The improved method expends more gunpowder, but causes a less exposure of human life, and is equally if not more prompt. With the petard, three men at least were required to place it, who were exposed to the fire of the assailed. By the plan now adopted a single man is exposed and the effect is as speedily and more effectually produced. In the experiment of yesterday, a strong gate had been constructed in an old sally-port of the French works, in front of the present citadel and strengthened by supports, so as to render it really as strong as, if not stronger than, the gates of most fortified places. At a signal given, a soldier rushed forward with a leathern bag containing 50lb. weight of powder; this he hung upon a gimblet which he quietly inserted in the gate, and lighting a half minute match, communicating with the powder, made his escape and placed himself under cover. The powder ignited and blew the gate and all around it to fragments, and a storming party entered.

ARAB SOLDIERS.

The following account of the pay, dress, and equipment of the regular troops of Abd-el-Kader is given by the *Constitutionnel.* The uniform of the infantry is composed of a jacket of grey serge without ornament, with a hood, a waist-

Digitized by Google

coat of blue serge, pantaloons of the same and a red cap. Every 3 months each soldier is supplied with a linen shirt and a pair of shoes of yellow leather. To this dress he adds at his own expense a burnous and a haik. The equipment consists of a cartridge box of morocco leather, suspended by a strap over the left shoulder, and attached to a belt. Each soldier has a musket and bayonet, and some have pistols and a yatagan, in the belt, but these latter are furnished by themselves. Every soldier receives daily a pound and a half of bread cake, and a pound of coarse flour, with which he prepares his couscoussou. Twice a week a sheep is given to every 20 men. The troops, however, find more considerable resources in pillage. The pay is from 4 to 6 boudjoux per month. The sub-lieutenants have 8 boudjoux, the lieutenants 12 and the agha only 36. The sub-lieutenants are distinguished by an embroidered sabre on each shoulder, the lieutenants have 2 sabres crossed. The Officers have also a silver ring on the third finger of the left hand, which is presented by the Emir. On this ring is a seal with the name, rank, and date of appointment of the officer. There is an agha or superior commandant of infantry for each khalifat, from whom he receives orders for the movements of the troops. There is also an agha in chief for the whole of the infantry with the Emir. The uniform of the regular cavalry of Abd-el-Kader does not differ from that of the French spahis. It is composed of a jacket of red cloth with black stripes on the sleeves and back, and a waistcoat of red cloth faced with blue. Each soldier adds to this uniform a muslin haik, with which he covers his head and shoulders, and which he ties with a cord made of camel's hide. This haik replaces the turban. The horse soldier receives a horse and harness but no burnous. He is armed with a musket without bayonet, or with a carabine, a sabre and a pistol. He has the same cartridge box as the foot-soldier. The spahis of the Emir are only regular cavalry in name, they are altogether without military instruction. The regular Cavalry have trumpeters like the French, and they sound in the same way. The Artillery is composed almost exclusively of French deserters, Turks and Koulouglis. The Emir has not a man capable of pointing a gun properly, and accidents in the military exercises are frequent. All the materiel is out of order and almost unfit for service. The guns are mounted on very heavy carriages with wheels of a single piece of wood.

Digitized by Google

EGYPTIAN ARMY, 1st MAY 1840.

Regular Forces—The Guard.

	Effective Strength.	*Where stationed.*
Regiment Artillery	1,372	*Hama.*
1st Regt. Cavalry	796	*Ladakiah.*
2d „ Cuirassiers.	844	*El Besan.*
1st „ Infantry	3,048	*Antab.*
2d „ „	2,645	*Marash.*
3d „ „	2,435	*Haleb (Aleppo.)*

The line—Artillery.

1st Regt. Horse Artillery.	982	*Homs.*
2d „ „ „	1,007	*Sham (Damascus.)*
4th „ „ „	337	*Akah (Acre.)*
1st Regt. Foot Artillery.	2,349	*Eskenderieh (Alexandria)*
2d „ „ „	1,949	*Haleb.*
1st Battalion „	379	*Hejjaz and Yemen.*

Cavalry.

1st Regt. of Cavalry	825	*Orfah.*
2d „ „ „	830	*Reamlah.*
3d „ „ „	847	*On march to Alexandria.*
4th „ „ „	678	*Adana.*
5th „ „ „	882	*On march to Alexandria.*
6th „ „ „	772	*Sham.*
7th „ „ „	742	*Tarsus.*
8th „ „ „	712	*Niaman.*
9th „ „ „	816	*On march to Alexandria.*
10th „ „ „	768	*Akah.*
11th „ „ „	756	*Kelis.*
12th „ „ „	762	*Tarsus.*
13th „ „ „	806	*Orfah.*

Infantry.

1st Regt. of Infantry.	2,251	*Antab.*
2d „ „ „	4,547	*Sudan.*
3d „ „ „	1,526	*Yemen.*
4th „ „ „	2,593	*Marash.*

Digitized by Google

	Effective Strength.	*Where stationed.*
5th Regt. of Infantry	2,629	*Adana.*
6th „ „ „	2,362	*Kelis.*
7th „ „ „	2,192	*Hejjaz.*
8th „ „ „	3,396	*Sudan.*
9th „ „ „	3,304	*Haleb.*
10th „ „ „	2,654	„
11th „ „ „	2,338	*Orfah.*
12th „ „ „	2,326	*Antab.*
13th „ „ „	1,525	*Hejjaz.*
14th „ „ „	1,988	*Haleb.*
15th „ „ „	2,555	*Derrieh.*
16th „ „ „	3,149	*Kandia.*
17th „ „ „	2,369	*Orfah.*
18th „ „ „	2,049	*Akah.*
19th „ „ „	2,349	*Hejjaz.*
20th „ „ „	2,677	*Yemen.*
21st „ „ „	2,203	*Hejjaz.*
22d „ „ „	2,212	*Orfah.*
23d „ „ „	2,342	*Yambo.*
24th „ „ „	3,131	*Kahirah (Cairo.)*
25th „ „ „	1,755	*Antakiah (Antioch.)*
26th „ „ „	3,318	*Kudsi Sherif (Jerusalem.)*
27th „ „ „	2,129	*Kahirah.*
28th „ „ „	1,446	*Defiles of Jadidi.*
29th „ „ „	3,172	„ „
30th „ „ „	2,925	*Adana.*
31st „ „ „	2,401	*Homs.*
32d „ „ „	3,318	*Haleb.*
33d „ „ „	2,604	*Kahirah.*
34th „ „ „	2,564	*Eskenderieh.*
35th „ „ „	3,918	*Kahirah.*
Invalids 6 Battalions	3,980	*Kahirah.*
Sappers 1st Regt.	812	*Akah.*
„ 2d Regt.	808	*Eskenderieh.*
Veterans 1st Battn.	791	*Eskenderieh.*
„ 2d Battn.	1,041	*Trabelus (Tripoli.)*
„ 29th Battn.	855	*Donkalah.*
Engineers 1st Battn.	758	*Edlib.*
„ 2d Battn.	808	*Eskenderieh.*
Miners 1 Company.	94	*Kahirah.*
„ Depôt	286	„
Veterans	1,671	*District of Baherieh.*
Artificers	185	*Kahirah.*

Digitized by Google

	Effective Strength.	*Where stationed.*
Carabineers & Musicians of Ibrahim Pasha.	1,152	*Syria.*
Carabineers & Veterans	306	*Hejjaz.*
Total	130,302	

IRREGULAR FORCES.

In the Hejjaz	4,059	Composed of	
In Yemen	2,944		
At Medina	8,255		
In Egypt	8,543	Cavalry	26,965
In Kandia	3,143	Artillery	2,977
In „	3,627	Infantry	11,736
In Syria	11,035		
Total	41,678		

NATIONAL GUARDS.

14 Regiments 47,800

RECAPITULATION.	REGULAR & IRREGULAR FORCES.
Cavalry	38,751
Infantry	101,953
Artillery	11,350
Engineers and other Corps	13,547
National Guards	47,800
Grand Total	213,396

CHINESE ARTILLERY.

However ancient may be the discovery among this people, of the composition of Gun Powder, its particular application to fire arms was probably derived from the west.*

The silence regarding cannon of the two elder Polos, who served at the siege of Siang-yang foo about the year 1273, and the circumstance of these persons having taught the use of the Balista for hurling stones to the Tartar Emperor, seem to prove that the Chinese at that period were as little acquainted with fire arms as Europeans.

Their history notices the use of a composition of the nature of Greek Fire, which, when thrown into the ditches that

* The Chinese name has no reference to guns, and simply means "Fire-drug."

Digitized by Google

surrounded cities, exploded in contact with water, and proved very destructive.

The invention of Powder, as compounded of "sulphur, saltpetre and willow charcoal" is carried far back by the Chinese, and was probably applied by them to fire-works, (in which they excel at present), or other harmless and useful purposes, long before their unwarlike spirit could have suggested the use of guns to themselves, or they could have borrowed the notion from Europeans.

It is reasonable to suppose, that the early discovery of the composition of Gun Powder was promoted by the abundance of nitre, a substance which abounds in the alluvial plains, near Peking, as much as it does in those of Bengal.

Mr. Wilkinson, of London, in a lecture on the subject of Gun Powder, has some observations deserving notice; he gives a table of the different quantities of nitre, charcoal, and sulphur, used by different nations in the manufacture, the proportion being expressed in 100 parts.

	Nitre	Charcoal	Sulphur	Total.
England	75	15	10	100
France	75	15.5	9.5	100
Sweden	75	16	9	100
Russia	70	18.5	11.5	100
Austria	76	13	11	100
China	75.7	14.4	9.9	100

The Powder manufactured in England (Mr. Wilkinson observes) is preferred in commerce to that of other countries of Europe, as being much the strongest. It may therefore be inferred that our proportions are the best; though no doubt the excellency of the Powder may partly depend on the purification and perfect admixture of the materials.

It is however worthy of observation, how nearly our proportions agree with the Chinese.

The Honorable Colonel Napier, when in the Ordnance Department, procured a sample of Powder from China, which on the average analyse of two ounces, was found to contain 720 grains saltpetre, 141 charcoal, 89 sulphur, and 10 loss. Dividing the deficiency equally, and reducing it to the proportion in 100 parts, gives the result in the above table.

And as they seldom change anything, it has probably been the same from the beginning; though, from the imperfection of the mixture and the impurity of the materials, their Powder may be inferior in strength to that produced in many other countries.

Digitized by Google

That it is sometimes tolerably efficient, was proved by a seaman killed at a gun on board the *Imogene* frigate, by a shot which first came through the ship's side. It must be observed, however, that the ship was then within pistol shot of the battery.

The Chinese we may remark, have always acknowledged their great inferiority in gunnery. Before the Jesuits taught them to cast cannon, there is reason to suppose that they used tubes of wrought iron bound together by hoops.

The last Emperor of the Ming dynasty, invited the assistance of some guns and artillerymen from the Portuguese of Macao, against the Tartars, and Kung-hy after the conquest of China, employed Pere Verbiest to superintend the casting of some hundreds of guns—a union of military pursuits with clerical, which brought some scandal upon the enterprising father at Rome.

One circumstance in the Chinese must tend very much to the imperfection of their gunpowder. Their munition of war seems, from the following extract of a Pekin Gazette for 1824, to be prepared by the troops themselves, as required.

"The governor of the Hoonan provinces has presented a "report concerning the death of several persons by the ex- "plosion of gunpowder, as they were manufacturing the "same in camp. While pounding the materials in a stone "mortar in the camp of the left division of the governor's "troops, a spark which was struck ignited the whole "quantity of powder and the explosion killed five soldiers, "together with six other persons."

The Chinese government have expended very large sums in the vain endeavour to render the entrance of the Canton river impassable to European ships of war.

The *Alceste* forced her way in 1816. The *Imogene* and *Andromache* in September 1834, two eight and twenty gun frigates, neared the entrance and got within range of the principal batteries; the wind, which had been right aft at starting, shifted to the north, and blew down the strait against them.

Digitized by Google

It now became a working passage, through a narrow channel about a quarter of a mile in breadth ; but the tide was running flood, and strong in their favour.

The action was most brisk in getting into the middle of the channel ; but the Chinese fired like men in a panic, aiming very wild or letting fly as the ships arrived nearly at the line of fire for each gun as it was laid.

There could have been very little reloading or training of the guns after the first few shots.

The whole of the slow working passage occupied nearly an hour and three quarters. Soon after the passage of the Bocca, the wind fell dead calm, and obliged the frigates to come to an anchor below Tiger Island which is some miles above the entrance.

They weighed to pass Tiger Island, through a deep but narrow channel close under the walls of the battery. The battery reserved its fire much longer than was expected, but the moment the first shot had passed the bows of the *Imogene*, leading ship, a most tremendous and well directed cannonade was opened by her which the *Andromache* took up as soon as she could bear on the fort.

The ships steered close to the fort, not more than 200 yards from the wall of the parapet overlooking them. The crews gave a loud cheer just as they got in front of the battery, and the effect was evident in slackening the fire of the enemy, so many of our 32 pounder shot entered the embrasures, or shattered the stone parapet, that the Chinese loss must have been considerable. Their battery was very severely punished, for the ships made good use of their time, and had learned from experience to be less sparing of their shot. Some buildings within the fort were a heap of ruins.

Considering that the batteries had at least 113 mounted guns, they ought certainly to have sunk the ships ; instead of which the whole damage done in both days was two *men* killed, half a dozen wounded, and a few ropes shot away.

The Emperor of China exclaimed " It seems that all the " forts are erected in vain ; they cannot beat back two " barbarian ships. It is ridiculous, detestable."

Digitized by Google

LANDING ARTILLERY.

The Detachment of Madras Artillery lately embarked on board of Her Majesty's ships for service in China,on effecting a landing on the island of Chusan, practised the mode of landing the guns, as laid down in the naval gunner by Lieutenant T. S. Beauchant, R. N. This method has not been laid down in any of the Madras Gunners, hitherto drawn up.

LIGHT FIELD BATTERY GUNS.

The number of men required is about 15, a launch and a pinnace are required for each gun and limber.

The gun is first to be put in the bottom of the launch, with two slings round it, to be in readiness for disembarking, the two gun wheels in the bow resting on their edges, and the carriage midships, the extremities of the axletree resting in two of the boat's rowlocks, which the room taken up by the carriage renders useless.

Six rounds of round shot and canister are to be put in the same boat in the stern sheets.

The other boat takes the ammunition boxes in the bottom, and the wheels and limber, stowed in the same manner as the gun carriage in the launch.

The men are disposed of as follows, 9 men in the launch to mount and serve the gun, 6 in the pinnace, to attend to the limber.

The drag ropes to be with the gun.

In the launch 4 men, Nos. 2, 3, 4, 5 are in the bow, and 5 men 1, 6, 7, 8, 9 in the after part of the boat.

The moment the head of the launch touches the beach the 4 men jump over the bow, and place the two wheels on the ground, above the wash of the sea; they return and haul in the boat which is then much lightened keeping her head in.

The 4 men in the after part of the boat jump over the side, the water being generally about knee deep, and with the assistance of the four midship boatmen, pass two bars

Digitized by Google

through the drag ropes that have been put round the carriage, so as to form loops.

Six or eight men (even Nos. on the right) will then raise the carriage and walk up to the wheels, assisted by two other men. The wheels being upright ready for fixing 2-4 the right, and 3-5 the left wheel ; while the linchpins and *washers* are fitting by 2 and 3, the remainder of the men return for the gun, pass the bars through the slings, and walk it over the bow of the boat to the carriage ; they then place it on its muzzle and mount in the usual way.

The ammunition during the time is getting ready, and the two stroke oars are kept out, to keep the boat's head to the beach.

As the gun and carriage are carried over the boat's bow, the movement would be retarded by allowing her to fall broadside on the shore.

The gun should be ready for action in two minutes from the time of the boats touching the beach.

The limber will be landed much in the same order ; but not until it is seen that the guns can keep their ground.

In embarking, the reverse of this system, must be followed.

The system of mounting and dismounting guns and carriages should be frequently practised on the quarter deck in fine weather.

Ammunition waggons, follow the limbers.

METHOD OF MOUNTING AND DISMOUNTING ORDNANCE.

1.—The light 6 pdr. and 12 pdr. howitzer are each mounted by their own detachments ; this may also be done with the 9 pdr. and the 24 pdr. howitzer ; but one or two men in addition will greatly facilitate the operation.

2.—Nos. 2, 3 attend to the cap-squares, and have charge of the muzzle and trunnions ; Nos. 4, 5 attend the cascable, and scotch the wheels of the guns, previous to raising the trail, No. 1 attends to the elevating screw.

3.—The carriages are mounted by their own detachments, with the 9 pounder and 24 pounder howitzer, Nos. 2, 3, 4, 5,

Digitized by Google

pass a handspike under one of the axletrees, and lift one side of the carriage at a time; Nos. 6, 7 put on the wheels. With the light 6 pounder and 12 pounder howitzer, Nos. 2, 3 in front, Nos 4, 5 in rear, lift the Carriage at once, Nos. 6, 7 each put on a wheel, Nos. 4, 5 attend to the washers and linchpins in both cases.

4.—The limbers and waggons are mounted in the same way. The whole detachment assists in lifting the boxes; after which Nos. 2, 4 lash on the near boxes, Nos. 3, 5 the off boxes of the limbers, No. 6 the front boxes, No. 7 the rear boxes of the waggon body.

FIRST MODE.

9 Pounder.

5.—The gun is supposed to be lying vent upwards.

A hole is dug close to the muzzle* and sufficiently large to receive it, the edge of the hole next the gun is cut down to facilitate the entrance of the muzzle, this will greatly diminish the difficulty of raising the piece, and the trunnions will be at a convenient height for entering the trunnion holes.

6.—A handspike is placed at right angles, under the neck of the cascable, and secured there, it is manned by Nos. 1, 6, 7, 8.

7.—Another handspike would be required with the gun of 13 cwt., and is placed under the first reinforce; it is manned by Nos. 2, 3, 4, 5, the two last numbers at the end of it, but is unnecessary with the 10 cwt. gun.

8.—The middle of a piece of a picket rope, or of a drag rope, is fixed by a clove hitch to the neck of the button by Nos. 4, 5, it is to be manned by men of the other gun detachment, who in order to act with greater effect take hold of it as near the cascable as possible. The carriage is brought close to the gun, leaving room, however, for the men to work.

9.—When every thing is ready, No. 1 gives the word "Heave," and as soon as the breech is as high as the men's hips, Nos. 2, 3, 4, 5 (two at a time) quit the handspike and man the rope, Nos. 1, 6, 7, 8 must attend carefully to the cascable as the breech is raised. When the piece stands

* On board ship, skids may be used under the wheels, or a cleat strong nailed to the deck in front of the muzzle to prevent the gun slipping, when being lowered into the trunnion holes will answer.

Digitized by Google

upon its muzzle, Nos. 2, 3, 4, 5 come up and steady the breech, while Nos. 1, 6, 7, 8 run the carriage within a foot of the gun; Nos. 6, 7 scotch the wheels, Nos. 1, 6, 7, 8 raise the trail, and when the trunnion holes are opposite to the trunnions Nos. 2, 3 push the gun over, Nos. 4, 5 bring the rope to the rear, and assist by hauling on it.

10.—When the gun does not exactly fall in the trunnion holes, it will probably be between them and the front bolts; in this case the rope is to be passed round under the cheeks, to secure the breech to the carriage, the trail is then lowered, when the piece will slide into the holes.

Light six Pounder. 11.—The gun Detachment is sufficient: No. 1 puts the rope round the cascable; it is manned by Nos. 2, 3, 4, 5, 6.

12.—The Carriage is run close to the gun, at the word "Heave," the men haul on the rope, and as the breech is raised, Nos. 2, 3 quit the rope to go to the cascable, and steady the gun; Nos. 1, 6, 7 run the carriage close to the gun; Nos. 4, 5 heave at the wheels and scotch them. The rope is passed to the rear to Nos. 4 and 5. Nos. 1, 6, 7 raise the trail of the carriage, and when it is high enough, Nos. 4, 5 haul on the rope, and Nos. 2, 3 push the gun into the trunnion holes; the trail is then allowed to come to the ground.

24 Pdr. Howitzer. 13.—The 24 pounder howitzer does not require a hole, a handspike is placed under the neck of the cascable, no handspike is required under the reinforce. Nos. 2, 3, 4, 5 man the cascable rope (See 9 pounder for the details.)

12 Pdr. Howitzer. 14.—The howitzer is supposed to be lying in the direction of the trail, the muzzle towards it, a handspike is lashed under the neck of the cascable, manned by Nos. 4, 5, 6, 7 and another is placed under the muzzle, manned by Nos. 2, 3. No. 1 steadies the piece by holding a trunnion in each hand. The howitzer is lifted bodily on the trail till the muzzle is beyond the shoe for the

Digitized by Google

handspike, where it is to rest on the trail it is then shoved up till the muzzle comes up to the elevating screw, upon the top of which it is to be lifted, the elevating screw having been run up two or three threads, so that the handspike may be withdrawn; Nos. 2, 3 shift to the front taking the handspike with them, put it into the bore, the howitzer is again lifted, and the elevating screw run down as low as possible; the howitzer is then lifted into the trunnion holes.

SECOND MODE.

16. One gun having been mounted by the foregoing mode, the others may be mounted more safely and expeditiously as follows :—

17. The elevating screw of the gun which has been mounted, is not put in, the breech rests upon the carriage, and is lashed to it by Nos. 4, 5– No. 6. attaches the rope to the trail. The gun is then run forward towards the muzzle of the dismounted gun, which is lying vent upwards. Nos. 4, 5, 6, 7 raise the trail of the mounted gun till its muzzle touches the reinforce of the other, to which it is firmly lashed by a piece of lashing rope by Nos. 2, 3—Nos. 4, 5, 6, 7 of the mounted gun, and Nos. 2, 3, 4, 5 of the dismounted gun, haul the trail down to the ground, which lifts the dismounted gun, this must be done very uniformly, as jerking it is apt to swing the muzzle under the carriage, and jam it against the axletree.

Nos. 1, 6, 7, 8 of the dismounted gun, run its carriage forward, so that the wheels of both carriages may overlap, which bring the trunnion holes under the trunnions. These Nos. perform all the duties about the trail of the carriage. The wheels are then scotched and the trail is raised.

The trail of the mounted gun is lifted a little at the same time, which lowers the gun into its place.

Digitized by Google

WEIGHTS AND MEASURES.—*Table of the Correspondence between Fahrenheit's, Reaumur's, and the Centigrade Thermometers.*

Weights.

The standard according to which the present system of weights is regulated, is the Troy brass pound, made in 1758, and now in the charge of the Clerk of the House of Commons. It contains 5760 grains.

Imperial Standard Troy Weight.

24 grains = 1 pennyweight.
20 pennyweights = 1 ounce.
12 ounces = 1 pound.

or

grains.		pennyweights.		ounces.		pound.
24	=	1	=	$\frac{1}{20}$	=	$\frac{1}{240}$
480	=	20	=	1	=	$\frac{1}{12}$
5760	=	240	=	12	=	1

Avoirdupois Weight.

The pound Avoirdupois contains 7000 grains, each of which is equal to a Troy grain, being thus heavier than the Troy pound by 1240 grains.

		1 drachm.....	=	27.34375 grains
16 drachms	=	1 ounce.....	=	437.5
16 ounces.	=	1 pound.....	=	7000
28 pounds.		1 quarter.....	=	196000
4 quarters		1 cwt or 112lb.	=	784000
20 cwts..	=	1 ton.....	=	15680000

or,

pound		ounces		drachms		grains
1	=	16	=	256	=	7000
$\frac{1}{16}$	=	1	=	16	=	437.5
$\frac{1}{256}$	=	$\frac{1}{16}$	=	1	=	27.34375

Apothecaries Weight.

The pound in Apothecaries Weight is equal to the Troy pound, containing 5760 grains, but is differently subdivided.

1 pound lb = 12 ounces = 5760 grains.
1 ounce ℥ = 8 drachms = 480
1 drachm ʒ = 3 scruples = 60
1 scruple ℈ = 20 grains = 20

Digitized by Google

or,

pound.		ounces.		drachms.		scruples.		grains.
1	=	12	=	96	=	288	=	5760
$\frac{1}{12}$	=	1	=	8	=	24	=	480
$\frac{1}{96}$	=	$\frac{1}{8}$	=	1	=	3	=	60
$\frac{1}{288}$	=	$\frac{1}{24}$	=	$\frac{1}{3}$	=	1	=	20

The following tables shew the correspondence between the Troy, Avoirdupois, and Apothecaries Weights.

Troy Weight.	*Avoirdupois.*	*Apothecaries.*
1 pound	=13oz. 2dr. 17.8125gr.	=1 pound
1 ounce	=1 1 15.15625	=1 ounce
1 pennyweight	=0 0 24	=1 scruple 4 grs.

175 pounds troy=144 pounds avoirdupois.
175 ounces troy=192 ounces avoirdupois.

Avoirdupois.	*Troy Weight.*	*Apothecaries.*
1 pound	=1lb 2oz 11dwt 16gr.	=1lb 2℥ 4℥ 2℈
1 ounce	=0 0 18 5.5	=0 0 7 0 17.5gr.
1 drachm	=0 0 1 3.34375	=0 0 0 1 7.34

Apothecaries.	*Troy Weight.*	*Avoirdupois.*
1 drachm	=2dwt 12gr.	=0oz 2dr 5.3125 gr.
1 scruple	=0 20	=0 0 20

French Decimal Weight.—*Gramme* =15.434 *Troy grains.*

Milligramme	=0.015434 grains.
Centigramme	=0.15434
Decigramme	=1 5435
Gramme	=15.434

MEASURES.

The Imperial Standard Gallon contains ten pounds Avoirdupois weight of distilled water, weighed in air at 62° Fahr. and 30° Barom. or 12lb 1 ounce 16 pennyweights and 16 grains Troy, =70.000 grains weight of distilled water. A cubic inch of distilled water weighs 252.458 grains, and the imperial gallon contains 277.274 cubic inches.

Imperial Measure

1 quarter	=8 bushels
1 bushel	=4 pecks
1 peck	=2 gallons
1 gallon	=4 quarts
1 quart	=2 pints

Digitized by Google

or

Distilled water

grains.	avoirdlb	cub. inch	pints.	quarts.	galls.	pecks.	bush.	qr.
8750 =	1.25	= 34.659	= 1					
17500 =	2.5	= 69.318	= 2	= 1				
70000 =	10	= 277.274	= 8	= 2	= 1			
140000 =	20	= 554.548	= 16	= 8	= 2	= 1		
560000 =	80	= 2218.191	= 64	= 32	= 8	= 4	= 1	=
4480000 =	640	= 17745.526	= 512	= 256	= 64	= 32	= 8	= 1

Apothecaries Measure.

The gallon of the former wine measure, and of the present Apothecaries measure, contains 58317.765 grains weight of distilled water, or 231 cubic inches, the ratio to the imperial gallon being nearly as 5 to 6, or as 0.83311 to 1.

1 gallon =8 pints
1 pint 0 =16 ounces
1 ounce $f\,\overline{3}$ =8 drachms
1 drachm $f\,3$ =60 drops or minims

or

gal.	pints	ounces	drachms	minims	gr. of dist. water	cub. inch.
1 =	8 =	128 =	1024 =	61440 =	58317.765	= 231
	1 =	16 =	128 =	7680 =	7289.721	= 28.875
		1 =	8 =	480 =	455.607	= 1.805
			1 =	60 =	56.951	= 0.226

French Decimal Measure of Capacity, Litre =61.0271 *British cubic inches, or* 15406.771 *grains of distilled water.*

	Cubic Inches	Grains of dist. water
Mililitre =	0.061 =	15.407
Centilitre =	0.6103 =	154.068
Decilitre =	6.10271 =	1540.677
Litre =	61.0271 =	15406.771

Lineal Measures.

The imperial standard yard is divided into 36 inches, and it has been found that a pendulum vibrating seconds of mean time in a vacuum at the level of the sea, in the latitude of London, the thermometer being at 62°, and the barometer at 30 inches, measures 39.1393 inches.

12in. = 1 foot
36 = 3 feet = 1 yard
198 = 16½ = 5½ yards = 1 pole
7920 =660 = 220 = 40 poles = 1 fur.
63360=5280 = 1760 = 320 = 8 furs· = 1 mile

Digitized by Google

French Measure of Length, Metre = 39.37079 *Imperial inches.*

Millimetre = 0.03937079 imperial inches.
Centimetre = 0.3937079
Decimetre = 3.937079
Metre = 39.37079
The French toise = 6.39495 imperial feet.
„ pied = 1.065825 „ foot.

TABLE *shewing the Weight in Grains of various measures (Apothecaries') of different fluids.*

	Specific Gravity.	Weight in Grains of			
		1 Pint.	1 Ounce.	1 Drachm	1 Minim.
Distilled water.....	1.000	7289.72	455.61	56.95	.949
Sulphuric Ether....	0.720	5248.60	328.04	41.00	.683
Alcohol	0.796	5802.61	362.66	45.33	.755
Solution of Ammonia	0.925	6742.99	421.43	52.68	.878
Muriatic Acid.....	1.118	8149.90	509.37	63.67	1.061
Nitric Acid.....	1.180	10788.78	674.30	84.28	1.404
Sulphuric Acid.....	1.848	13471.40	841.96	105.24	1.756

MODE OF REDUCING TO EACH OTHERS STANDARD, DEGREES IN FAHRENHEIT'S, REAUMUR'S, AND THE CENTIGRADE THERMOMETERS.

The space between the boiling and freezing points of water is divided into

180 parts or degrees in Fahrenheit's Thermometer.
100 „ „ in the Centigrade.
80 „ „ in Reaumur's.
Therefore

Fahren.	Cent.	Reaum.
180 degrees =	100 =	80
1 =	$\frac{5}{9}$ =	$\frac{4}{9}$
$1\frac{1}{5}$ =	1 =	$\frac{4}{5}$
$2\frac{1}{5}$ =	$1\frac{1}{4}$ =	1

In Fahrenheit's Thermometer the graduation begins at 32 degrees below the freezing point of water. The Centigrade and Reaumur's commence at this point.

Accordingly,

1. To reduce the Centigrade degrees to Fahrenheit's, multiply by 9, divide by 5, and add 32.—thus,

40 C. × 9 = 360; $^{3}\frac{6}{5}{}^{0}$ = 72; 72 + 32 = 104 Fahrenheit.

Formula $\frac{C \times 9}{5} + 32 = F.$

Digitized by Google

2. To reduce Fahrenheit's to the Centigrade, subtract 32, multiply by 5, and divide by 9.—thus,

104 Fahr.—32 = 72 : 72 × 5 = 360 ; $\frac{360}{9}$ = 40 Centigrade.

Formula F.—$\frac{32 \times 5}{9}$ =C.

3. To reduce Reaumur's to Fahrenheit's, multiply by 9, divide by 4, and add 32.—thus,

R32× 9 = 288 ; $\frac{288}{4}$ = 72 ; 72 + 32 = 104 Fahr.

Formula $\frac{R \times 9}{4}$ + 32 = F.

4. To reduce Fahrenheit's to Reaumur's, subtract 32, multiply by 4, and divide by 9.—thus,

Fahr. 104—32 = 72 ; 72 × 4 = 288 ; $\frac{288}{9}$ = 32 R.

Formula $\frac{F.-32 \times 4}{9}$ = R.

5. To reduce Reaumur's to the Centigrade, multiply by 5, and divide by 4.—thus,

R 32 × 5 = 160 ; $\frac{160}{4}$ = 40 Centigrade.

Formula $\frac{R \times 5}{4}$ = C.

6 To reduce the Centigrade to Reaumur's multiply by 4, and divide by 5. Thus,

C. 40×4=160 ; $\frac{160}{5}$=32 Reaum.

Formula $\frac{C \times 4}{5}$ = R.

TABLE

shewing the correspondence between Fahrenheit's, Reaumur's and the Centigrade Thermometers.

F.	C.	R.	F.	C.	R.	F.	C.	R.	F.	C.	R.	F.	C
—40—	40—	32	+14—	10—	8	+68+	20+	16	+122	+50	+40	+176	+80
—31—	35—	28	+23—	5—	4	+77	+25	+20	+131	+55	+44	+185	+85
—22—	30—	24	+32	0	0	+86	+30	+24	+140	+60	+48	+194	+90
—13—	25—	20	+41+	5+	4	+95	+35	+28	+149	+65	+52	+203	+95
— 4—	20—	16	+50+	10+	8	+104	+40	+32	+158	+70	+56	+212	+100
+ 5—	15—	12	+59+	5	12	+113	+45	+36	+167	+75	+60	&c.	

In this table it will be observed that the numbers in Fahrenheit's scale advance by 9, in the Centigrade by 5, and in Reaumur's by 4.

Digitized by Google

Table of effects of heat and Cold.

Fahrenheit.

—135° Greatest artificial cold that has yet been observed.
—121 Solid compound of alcohol and carbonic acid melts.
— 92 Greatest artificial cold, as measured by Walker.
— 55 } Greatest natural cold observed by Parry.
} Note.—Ross states it at 60°
— 50 Cold observed at Hudson's Bay.
— 47 Sulphuric ether congeals.
— 40 Sulphuric ether boils in vacuo.
— 39 Melting point of solid mercury.
— 23 Observed on the surface of the snow at Glasgow, 1780.
— 7 Brandy freezes.
+ 16 Oil of turpentine freezes.
20 Strong wine freezes.
25 Human blood freezes.
28 Vinegar freezes.
30 Milk freezes.
32 Ice melts.
36 Olive oil freezes.
50 Medium temperature of the surface of the globe.
52 Mean temperature of England.
98 Ether boils.
98 Heat of human blood.
173 5 Alcohol boils.
212 Water boils.
442 Saturated solution of sea salt boils.
242 Tin melts.
554 Phosphorus boils.
570 Sulphur boils.
612 Lead melts.
650 ? (662 ? Dulong.) Mercury boils.
773 Zinc melts.
800 or 810 Ignition visible in the dark.
900 to 1100 Heat of a common fire.
1869 Brass melts.
1873 Silver melts.
1996 Copper melts.
2016 Gold melts.
2786 Iron melts.
3280 Temperature of the maximum expansion of platinum
? Heat of the oxyhydrogen blowpipe, of the galvanic battery, &c. &c.

Digitized by Google

Digitized by Google

MEMORANDUM ON THE RECENTLY APPROVED SMALL ARMS OF THE BRITISH ARMY, WOOLWICH, JULY 1838.

1. Musket, weighs complete..... 10 lbs 0 oz.
   Bayonet..... „ 15 oz.
   Barrel { Length..... 3 feet 3 ins..
   Diameter of bore.... ·753 ins.
   Charge..... 4½ drachms.

2. Rifle, weighs complete..... 9lbs „
   Sword Bayonet..... 2 „ „
   Barrel { Length..... 2 feet 6 ins.
   Diameter of bore.... ·704 ins.
   Charge..... 2½ drachms.

3. Carbine, weighs complete..... 7lbs 0 oz.
   Barrel { Length..... 2 feet 2 ins.
   Diameter of bore.... ·723
   Charge..... 3½ drachms

Ball, 14½ to the lb. the diameter of the ball is ·683 ins. so that the same will serve for all the small arms in the British Service—it will be observed that the diameters of the bores of the Musket, Rifle and Carbine, differ in a trifling degree—it being necessary to allow more windage to the musket for quick and continued firing.

The Rifle has only *two* grooves, these have a whole turn in the length of the barrel. The ball for the Rifle, has a belt or zone on it to fit into these grooves, this belt increases the weight of the ball to about 13 to the lb.—but the round ball makes very good practice from the Rifle with the same charge 2½ drachms.—*Fig.* 7.

Lock. Percussion back actioned the same for all the small arms.

The nipple to receive the percussion prime, the same for all, *universal.*

Prime. Copper Cap—Percussion—the same for all description of small arms.—*Fig.* 8.

It is proposed to allow 90 copper caps for the 60 rounds of ball cartridges, they are packed in small parcels of 30 each and 3 of these parcels go into a tin Can of about the size of a bundle of 10 ball cartridges of 4½ drachms.

Digitized by Google

The blank cartridges for exercise will remain the same 4 drs. but the proportion of copper caps, for the blank cartridges will be the same as for the ball cartridges viz. 3 to 2.

The old dimensions of the Musket barrel, bore and ball have been kept. The Rifle and Carbine have been assimilated to the Musket.

Fig. 9. Is a Cartridge for the percussion rifle used by H. M. 26th or Cameronian Regiment.

MR. ROBERTS' MODE OF BLASTING ROCKS BY THE AID OF GALVANISM, AND OF DETONATING GUNPOWDER UNDER WATER—FIG. 10.

N, P, N P, N, P, represent the positive and negative wires from a galvanic trough, each wire being surrounded with cotton, so that electricity cannot pass from one to the other, except by the small wire, as represented in the magnified figure with the attached arrow. This little wire connecting the positive and negative wires, becomes incandescent when the galvanic trough is put in action, detonates the gunpowder in the cartridge in which it is contained, which inflames the additional gunpowder F F, in which it is imbedded ; S S represents straw used in Mr Roberts' arrangements for supporting the gunpowder and the sand, &c. Z. The effect of the powder is increased, according to his views, by leaving atmospheric air above and below it, as at G. The galvanic trough being arranged and in action, the moment the string H is pulled, it moves the light frame C C, and causes the metallic plate B. previously held back by a spring coiled upon the wooden frame A. to touch A ; and the galvanic circuit being now completed, electricity passes at once from P to N, detonating the gunpowder as the little wire is ignited.

The metallic wires do not require to be above twenty or thirty feet long and the operator may retire to any distance before he pulls the string H ; the effect of the blast is considerably increased by there being no vent required, as in the usual mode for igniting gunpowder. One of Young's troughs ,with twenty pairs of plates, the plates being about four inches square, does very well for the purpose. It may be charged with a solution of sulphate of copper, acidulated with sulphuric or nitric acid. The metallic wire in the gunpowder, connecting the positive and negative poles of the trough, cannot be too small ; it may be made of platinum, but steel wire has been preferred.

Digitized by Google

Miscellaneous.

New Rifle ball

fig. 7



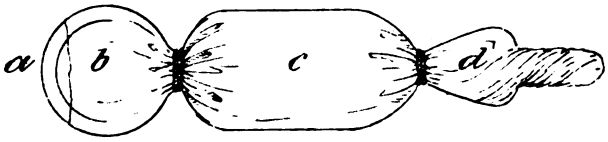
Prime or Percussion Cap

fig. 8



Cartridge complete

fig. 9



a....Ball
b....Greased patch
c....Cartridge
d....Percussion Cap

Digitized by Google

Digitized by Google

Mode of Detonating Gunpowder under water by Mr. Roberts.



fig. 10

Digitized by Google

Digitized by Google

Miscellaneous continued.

EXTRACTS FROM THE STATISTICAL NOTES ON CHUSAN BY LIEUTENANT OUCHTERLONY, MADRAS ENGINEERS.

" Several average samples of the gunpowder found in the " Arsenals of Chusan, produced on analysis a mean of the " following results."

" Nitrate of Potash.....	77	100
" Sulphur.....	13	
" Charcoal.....	9	
" Water.....	1	

" Some appeared to be granulated and even glazed with " considerable care, but much unevenness and inequality are " discernible in the greater portion, and the result of expe- " riments on its strength by the Madras Artillery was " generally unfavourable."

" Some saltpetre was also found, together with a small " quantity of sulphur, part of which was evidently native and " not sublimed from sulphureous ores; the saltpetre was " well refined—up to 4 to 9 refraction, and was principally in " the state of coarse prunelle not entirely freed from water " of crystallization."

" The art of casting in iron seems to be familiarly known " to the Chinese, and although the guns and shot, found in " store in the Island, may be pronounced rude and clumsy " in the extreme, the strength, finish and even elegance of " some of the tripods, incense burners etc., seen in certain " Joss houses, afford evidence of the skill which they have " the power of exerting, when the views of their Government " may permit of its display in the manufacture of the more " ponderous engines of war. Some sword blades in the Ar- " senals also appeared to be of sound material, and well cut- " ler'd and tempered; the major part however were of com- " mon wrought iron."

Digitized by Google

METALLIC CONDUCTORS TO POWDER MAGAZINES, AS A SECURITY AGAINST LIGHTNING.

Extract of a letter from Major H. Moberly, Secretary to the Military Board, to the Secretary to Government Fort Saint George, dated 13th February 1838.

"In July 1836, Government were pleased, on the recommendation of the Military Board, to authorize the provision of a copper conductor for lightning for the Artillery Regimental Magazine Trichinopoly. The circumstance gave rise to a proposition, that all Magazines for containing gunpowder should be furnished with similar expected means of security, orders were accordingly given to prepare a plan and estimate for conductors to the Magazines in Fort St. George, Black Town, the Powder Mills, and St. Thomas's Mount, I have now the honor under orders of the Military Board to submit the plan and estimates amounting in the aggregate to Rs. 3227-12-4, but before recommending them for sanction, to observe that the Board are not aware of any instance of a Powder Magazine having been struck by lightning under this Presidency, and that the question of additional security to be derived from conductors, is still they conceive an undecided point in Europe. The Board therefore suggest that the subject may be referred for the opinion of scientific Gentlemen, and also to the other Presidencies ; Magazines having not long since exploded both in Bengal and Bombay, but whether from the effects of lightning, or otherwise the Board are not informed."

Extract of a letter from Lieut.-Colonel E. M. Wood, Secretary to the Government of Bombay, to the Secretary to the Government of Fort Saint George, No. 1534, *dated 26th May* 1838.

"I am directed to acknowledge the receipt of your letter No. 1055, dated 20th March last, with its enclosure, and in reply to transmit the accompanying copies of a letter from the Commandant of Artillery dated 15th Instant, with its several accompaniments relative to the advisability or otherwise of affixing metallic conductors to Powder Magazines for greater security against lightning."

Digitized by Google

Extract of a letter from Lieut.-Colonel J. G. Griffiths Commandant of Artillery, to the Secretary to Government of Bombay, No. 69 of 1838, dated 15th May 1838.

"In acknowledging the receipt of your letter of the 3d April No. 1005, calling upon me for my opinion as to the expediency of affixing metallic conductors to Powder Magazines for greater security against lightning or otherwise? and to afford any information that I may be able to adduce on the subject, I have the honor to state, that I have always been an advocate for attaching conductors to public buildings of any considerable height, and more particularly to Powder Magazines, as a necessary precaution against danger which might be much more extensive without them."

"I beg also to forward the opinions of Lieutenant Colonel Manson, C. B. and of Captain Jacob, the former and present agents for the manufacture of gunpowder, who have more particularly had this subject brought to their notice, and altho' they appear to take contrary views of the question, I am happy to add a more confident opinion on this interesting subject, in corroboration of the one I had formed on it. The accompanying extract from the Proceedings of the (7th) British Association held at Liverpool last September, will shew that the subject had recently occupied the attention of the first philosophers of the age, and that it appears to be universally admitted, that the use of conductors are necessary for the safety of all buildings, and by the same reasoning for all Powder Magazines."

Extract of a letter from Lieut.-Colonel A. Manson, to Captain Coghlan, Major of Brigade Bombay Artillery, dated Ahmednuggur 26th April 1838.

"I have to acknowledge your letter of the 18th Instant, regarding the reference from Madras as to the security to be derived from attaching *rods* for conducting lightning from Powder Magazines, and as requested by the Commandant of Artillery, beg to state that in my opinion the advantage to be derived from the measure is very questionable, nor am I at all satisfied that such a proceeding instead of tending to security, may not unfrequently prove the reverse."

Digitized by Google

"I have understood that *trees* somewhat near Magazines are considered advantageous; as being more likely to attract lightning than any building in their vicinity."

"In respect to the several explosions at the Powder works that have taken place within my recollection, I have to observe that I can remember two accidents of the sort only —one in 1824, and another very serious one in 1826. The causes of these were never ascertained, but neither occurred by lightning."

Extract of a letter from Capt. W. Jacob, Agent for gunpowder, to Captain Coghlan, Major of Brigade Bombay Artillery, dated 28th April 1838.

"In reply to your letter No. 148 of the 18th instant, I do myself the honor to state, that there is no instance either upon record in this Office, or in the recollection of the oldest persons connected with these Powder works, of explosions ever having been occasioned by lightning, I have taken some pains to trace up the accounts of accidents of this description in these works from so far as discoverable since 1784, and I herewith beg to forward an abstract of them, shewing their effects and the causes to which they were respectively *ascribed*; at the same time, when the situation of the grand Magazine (containing probably from two to three hundred thousand pounds of Powder in deposit) is considered, surrounded by the buildings of the Powder Manufactory with about 25,000lbs. of Powder in process, distributed in the different mills, presses, drying terraces &c. there can be no doubt, that a well constructed conductor for lightning to the Magazine would be a very desirable precaution for its protection, and that of the valuable property around, which would all be sacrificed were this Magazine to share the fate of that at Dum Dum in Bengal, which in June 1836, I understand blew up from being thus struck by lightning—it may be as well to state that about 20 years ago, the old Flag staff at the wicket gate of the Powder works was struck and shivered to pieces by lightning, which confirms the propriety of having a metal conductor attached to the grand Magazine, which it would be advisable should be completed if possible before the usual thunder-storm occurs at the setting in of the monsoon in June."

Digitized by Google

Return of Explosions, Accidents, &c. occurring in the Gunpowder Manufactory from the year 1799 up to 1838, as extracted from the Official Records in the Office of the Powder Agent.

Date of Accidt. or explosion.	Agent's name at the time.	In what part of Works occurring.	Injury done.	Cause or origin of the explosion and Remarks.
1784.	Unknown.	Beating Mill.	56 lives lost and building entirely destroyed.	Referred to in Doctor Scott's Report dated 4th January 1807, caused it is supposed by friction on the Mill.
About 1790.	Mr. Galley.	Pestle or Beating Mill.	Particulars Unknown.	Unknown.
About 1794.	Mr. Holanby.	Ditto.	Ditto.	Ditto.
About 1794.	Mr. Holanby.	Cylinder House.	6 Cylinder Mills and 12 people were blown up.	Ditto.
About 1795.	Mr. Carnac.	Sifting House.	Entirely destroyed.	Caught fire by being too near a granulating house which exploded.
About 1796.	Mr. Carnac.	Cylinder House.	6 Cylinder Mills and 12 people were blown up.	Unknown.
25th Jan. 1799.	Helenas Scott.	Granulating House.	2 Granulating houses destroyed, 32 men killed and 4 wounded.	Explosion occurred in Granulating house, supposed to have been occasioned by the *Concussion*, in breaking the Powder cakes with black wood mallets on wooden platform, the weather was fine and the time of its occurring about 11 o'clock in the day.
Feb. 1802.	Helenas Scott.	Granulating House.	Etirely destroyed the building but no life lost.	The fire did not begin in the house but at some distance on the outside near the door, the wind which is constantly blowing a little of the fine dust out at the door and windows, had covered the floor and entrance with a thin stratum of

Digitized by Google

Date of Accidt. or explosion.	Agent's name at the time.	In what part of Works occurring.	Injury done.	Cause or origin of the explosion and Remarks.
				Gunpowder, this stratum took fire several feet from the door, where there was nobody near it and gradually ascended into the house which exploded, the fire was fortunately seen by people at a distance before it got into the house and advancing but slowly so that the people had time to retire without suffering any hurt. In this case (writes Doctor Scott the Agent) I can have no doubt but that the sun set fire to the thin stratum of powder and this was probably effected by the rays passing through some particle of sand which being of the form of a lens produced the degree of heat necessary to explosion.
22d Feb. 1804.	Helenas Scott.	Pestle or Beating Mill.	Unknown.	Unknown.
12th Dec. 1806	Helenas Scott.	Beating Mill.	Building destroyed but nobody injured.	Cause unknown, but supposed to have been occasioned by friction with some silicious matter: 2 Fire Engines were in consequence of this accident applied for by Doctor Scott, to be attached to the Powder works and were sanctioned.
30th Dec. 1806	Helenas Scott.	Cylinder House.	10 lives lost and building destroyed containing 6 Cylinders.	One very chief cause of the late explosion, I now firmly believe, (writes Doctor Scott on 4th January 1807) is the prodigious quantities of dust that cover our works whenever there is wind, the dust consists of earth with powdered sand, which on being struck will readily produce sparks.

Digitized by Google

Date of Accidt. or explosion.	Agent's name at the time.	In what part of Works occurring.	Injury done.	Cause or origin of the explosion and Remarks.
15th Dec. 1817	Dr. Inverarity.	Beating Mill.	One man killed, and two wounded, roof of building destroyed, but further injury averted by the speedy application of the Fire Engines attached to the works.	Cause unknown—the only man in the Beating Mill was the unfortunate man killed who was employed in turning the composition, the two men wounded, were in the adjoining room one subsequently died of his wounds.
28th May 1825	Capt Manson.	Outside boundary. Cylinder Mill.	Building nearly destroyed, one man and Buffalo severely wounded.	Cause Unknown.
18th Aug. 1826.	Capt. Manson.		The whole range of Building containing 6 Mills and one godown were destroyed, the Naigue and 3 Sepoys on guard killed, and 2 men also in the Magazine dock, and 1 man who was in a boat near the works. 175,000lbs. of Powder in cake composition and other processes exploded and 10 other buildings were wholly or partially destroyed.	The explosion occurred ¼ before 12 o'clock at night the effect was tremendous completely destroyed the buildings as well as injuring all others within the influence of its destructive range and some of the burning timber falling through a range of Saltpetre, Sulphur, and other godowns a most alarming and destructive fire broke out almost immediately afterwards, which raged incessantly until about 3 o'clock in the afternoon of the 20th when it was fortunately got under. Cause of this explosion unknown.

Digitized by Google

Date of Accidt. or explosion.	Agent's name at the time.	In what part of Works occurring.	Injury done.	Cause or origin of the explosion and Remarks.
22d Oct. 1837.	Capt. W. Jacob.	Charcoal cylinder mill, outside northern boundary.	Whole building destroyed, 3 men died of their wounds in the Native General Hospital, and 4 men wounded but recovered.	Spontaneous combustion of charcoal—which had remained 48 hours untouched in a pulverized state. It appeared the unfortunate victims injudiciously poured water upon the charcoal when discovering it to be on fire, which blew up at once with a loud explosion; the instant presence of the whole of the labourers and two fire engines, got the fire under with the loss of that mill only.

REMARKS.

Besides the above, several spontaneous ignitions of powdered charcoal have taken place within the last 10 years, but have not been attended with loss of life, or material injury to the buildings from having been discovered in time, and prompt assistance having been rendered in removing the combustible material.

GUNPOWDER MANUFACTORY,
BOMBAY, 28*th April*, 1838.

(Signed) W. JACOB, Captain Artillery,
Agent for Gunpowder.

Digitized by Google

Extract from the Proceedings of the 7th British Association held at Liverpool in September 1837—*Mechanic's Magazine for October* 1838.

" A letter was read, addressed by Mr. Locke to Mr. W. Currie, in which the latter was requested to propose as a question to the Philosophers assembled, whether in the case of a monument 140 feet in height erected on the summit of a mountain 1400 feet high, augmented safety or danger, would be the consequence of attaching to it a conductor or paratonnere ? The column is sandstone, the mountain conglomerate, and in the vicinity of the latter there is a mountain of still greater elevation. It was resolved, that this letter should be *pro-forma* put into the hands of Mr. Snow Harris, though no doubt whatever was felt as to the answer which it would be proper to give to such an enquiry. *The efficacy of the protectors of Franklin, in every possible situation, provided they be constructed upon proper principles, and mounted in a suitable manner, is now universally admitted.*

No. 2157.

Order thereon.—Ordered that the foregoing Despatch be communicated to the Military Board in reference to their Secretary's letter dated the 13th February last, No. 82.

Fort St. George, 22d *June* 1838. (Signed) S. W. Steel, Lieut. Col. *Secy. to Govt.*

Military Department.

No. 1951.

Extract from the Minutes of Consultation

7th May 1839.

Read again letter from the Secretary to the Military Board dated 13th February 1838, No. 82, recorded in Minutes of Consultation of the 20th March 1838.

Read the following Letter.

From the Secretary to the Government of India, conveys the opinion of the Government of India that it is

Digitized by Google

not expedient for certain reasons, which are stated, to furnish Magazines for gunpowder, with copper lightning conductors.

Here enter 15th April 1839.

In reference to an Extract from the Minutes of Consultation No. 2157, of the 22d June 1838, and to the foregoing letter from the Secretary to the Government of India dated 15th Ultimo No. 319, the Right Honorable the Governor in Council directs that no more lightning conductors be put up to Powder Magazines under this Presidency.

(Signed) S. W. STEEL, Lieut. Col.
Secy. to Govt.

Extract of a letter No. 614, *from Lieut. Col. J. Stuart, Secretary to the Government of India Military Department, to the Secretary to Government in the Military Department Fort St. George, dated Fort William, 25th March* 1840.

"With reference to letter from this Department, No. 319, dated 15th April 1839, I am directed by the Right Hon'ble the Governor General of India in Council to transmit to you for the purpose of being laid before the Right Honorable the Governor in Council, the annexed extract (paragraphs 61 to 63) of a Military Letter from the Honorable the Court of Directors, No. 71, dated 20th November 1839, together with a copy of the reports from Professors Daniell and Faraday therein referred to."

2d. "The report of the Committee appointed by the Lords of the Admiralty, referred to in paragraph 62, has not yet been received."

3d. "The Military Board at this Presidency have been called upon, with reference to paragraph 63, to furnish a further report on the subject of providing lightning conductors to Powder Magazines."

Digitized by Google

Extract of a Military Letter from the Hon'ble the Court of Directors, No. 71, dated 20th November 1839.

Para. 61. "In our letter dated the 25th September 1839, No. 54, paragraph 28, we informed you that it was our intention to circulate the papers received from you on the subject of lightning conductors to Powder Magazines, amongst scientific persons in this country who had given particular attention to electricity and the means of averting its injurious consequences, and that the opinions and remarks we might receive in reply should be duly communicated to you."

62. "We have since received and now forward to you reports on the subject from Professors Daniell and Faraday; also a copy of the report by the Committee appointed by the Lords of the Admiralty for ascertaining the efficiency and best form of lightning conductors for Her Majesty's Navy, and a copy of Mr. Arago's detailed scientific notice "*Sur le tonnere*" published in the "*Annuaire*" of last year."

63. "As all these authorities are unanimous in advising the use of lightning conductors, we would strongly recommend that your decision to withhold this supposed means of safety from "Powder Magazines in India may be immediately reconsidered."

No. 1820.

Ordered, that the foregoing letter and its enclosures be communicated to the Military Board, but that no steps be taken towards the construction of lightning conductors for Magazines under this Presidency, pending the receipt of the report referred to in the 3d paragraph which the Government of India will be requested to cause to be furnished to this Government when received.

Extract of a letter No. 279, from Lieut. Col. J. Stuart, Secretary to the Government of India Military Department, to the Secretary to Government Military Department Fort Saint George, dated Fort William, 21st October 1840.

"With reference to your despatch No. 1819, of the 2d of May last, I am directed to transmit to you, for the purpose of being laid before the Government of Fort Saint George, the accompanying copy of Professor O'Shaughnessy's further report, on the subject of providing lightning conductors, to Powder Magazines."

Digitized by Google

No. 4196.

Ordered, that the above letter and enclosure be communicated to the Military Board, in reference to Extract No. 1820, from the Minutes of Consultation, dated the 2d of May 1840.

FORT SAINT GEORGE, 17*th November* 1840. } (Signed) S. W. STEEL, Lieut. Col. *Secy. to Govt.*

Letter from W. B. O'Shaughnessy, Esq. M. D. Assistant Surgeon, to Captain H. De Bude, Officiating Secretary to the Military Board, dated Calcutta, 24th June 1840.

In compliance with your request that I should draw up a further statement of my opinions regarding the attachment of conductors to Powder Magazines, I have the honor to submit the subjoined observations to the consideration of the Military Board.

2d. I regret much that it is impracticable to accord me the full measure of time, desirable for the collection and accurate examination of the numerous facts to which I have obtained a due bearing on the question now before us, and many of which corroborate powerfully the views I entertain. I regret this the more, as I have the misfortune to differ in a slight degree with the opinions Mr. Faraday has given, while those which Mr. Daniell somewhat dictatorially professes are wide at variance with mine.

3d. I trust I may be pardoned by the Military Board for here publicly placing on record, a tribute of my deep respect for Mr. Faraday's labors in electrical science. This department of physics he has made peculiarly his own. My presumption would be measureless were I to depart from the utmost modesty and hesitation, when I venture to persevere in an opinion from which he ever so slightly dissents. I seek however for no more candid judge than this illustrious philosopher, and on once more referring the subject to his consideration, I will bow to his contrary decision with the full conviction that I had acted upon erroneous views.

4th. Mr. Daniell's facts and arguments will be treated *ad valorem* in the subsequent observations. I have only to observe that in the further discussion of this question, it would be well if he would condescend to use a more courteous tone, and to recollect that his opinions as well as mine

Digitized by Google

have to bear the scrutiny of individuals who are not very likely to be influenced by the mere reputation of any of the parties concerned.

5th. The question before the Board is this exclusively, "Are we to attach lightning rods to *Powder Magazines*, and if so, how are we to place them so as to ensure the maximum of safety from every accident." To this question and its bearings we must limit this discussion. It is altogether a different matter from that with which Mr. Daniell has mixed it up, namely, the attaching of conductors to private dwellings or ordinary buildings, all the circumstances differ so widely, that many of the most important of the facts and arguments which bear on one, are altogether inapplicable to the other.

6th. The necessity for attaching lightning rods to Powder Magazines in tropical regions visited by frequent and violent thunder-storms, might at first sight appear so obvious as to need no further consideration. The document (No. 1,) however shews, that of all the Magazines in the territories of the Hon'ble East India Company (Bengal Presidency) during a period of forty years, only one has been struck by lightning, namely, that at Dum-Dum in the month of June 1836. It will be seen as we proceed, that the term Magazine was scarcely applicable to the building there destroyed.

7th. I stated in my first report on this subject, that I considered a Powder Magazine *when properly constructed* arched and rounded in its outlines, of low elevation, and free from metallic masses in its walls and roof, to be as little exposed to accidents as an equal area of soil or terrace, the chances of which being struck by lightning are so infinitely small as scarcely to deserve serious consideration. The Dum-Dum explosion took place in a common building of square form formerly a godown. It was not a "Magazine" but a mere store room for the powder used for the Laboratory. It stood in the corner of a yard crowded with guns, gun carriages, heavy metal, tools, shells and other powerful conductors of electricity. It was exactly what it ought not to have been, and the explosion which occurred, by no means invalidates the position that the well constructed Magazine has but an infinitely small chance of being struck by lightning.

8th. The questions now arise 1st, would even this minute contingency be obviated thoroughly by lightning conductors being attached to the Magazine, on the method advised by

Digitized by Google

the Hon'ble the Court of Directors ; secondly, can the conductor itself by possibility become a source of collateral danger.

General effects of Conductors.

9th. I will take up each of these questions in detail, I grant in the first place as the foundation of the argument, that metallic conductors have the power when properly placed of *silently* drawing off *considerable* accumulations of electricity from the clouds ; and secondly, of guiding away to the earth *considerable* direct *explosive* discharges or *flashes* of *lightning* without permitting the electric matter whatever it be to impinge directly on any adjacent bodies.

Extent of area each protects.

10th. The extent to which the protecting influence of a conductor extends laterally, has long been a subject of attention and discussion. Levoy in 1783, asserted that a rod 4 to 5 metres high, above the roof of an ordinary building defended a circle of 16 metres radius, or more than three times its own elevation.

Opinion of Accademie des Sciences.

11th. The academy of sciences in 1823, in a report to the Minister of War, adopted the opinion of M. Charles, that the circle protected was a radius, double the total elevation of the conductor *above the roof*. This opinion seems to have been generally adopted, but must be modified in consideration of the facts which M. Arago has collected, and some which have come under my own observation.

See the Almanac for 1838.

Accident to the Purfleet Magazine.

12th. If masses of metal of any kind enter into the construction of a building, the protecting influence does not extend to the distance above-mentioned. The Powder Magazine of Purfleet provided with a conductor erected by Franklin and Cavendish, was struck by lightning 24 feet from the nearest part of the conductor which was 26 feet above the roof, the distance being less than the simple height, the part struck containing a metallic cramp.

Do. to a tree near a Steeple.

13th. Dr. Winthrop, of New Cambridge, reports, that a tree was struck by lightning when but 50 feet from the conductor attached to the steeple of a church, which may reasonably be supposed to have been at least 50 feet higher than the tree.

Digitized by Google

Necessity of numerous Conductors

14th. All that we are entitled to infer from the facts before us is, that in order to give safety from direct and *ordinary* discharges, we must erect so many conductors that no point of the roof shall be farther from the conductor than twice the length of the height of the conductor above the level of the roof, and this applies only to flashes from clouds in a calm atmosphere and above the building. The area of protection is unquestionably much contracted under the circumstances so common in India, of a thunder-cloud being blown with hurricane velocity across a plain before a furious squall. Nothing but a line or a chain of conductors connected together by horizontal metal bars, and surrounding a building can possibly protect it from discharges under these paroxysmal storms. This is the opinion I offered in my first report dated the 27th December 1838, and I have now but to repeat, that one or even two conductors are not an adequate protection, and to *ensure* safety several must be erected. The subsequent considerations will probably bear me out in stating, that a properly built Magazine with but one or any inadequate number of conductors, is in greater danger of explosions than if it had none, and that with ever so many conductors these should be placed at a considerable distance from its walls.

In a line or chain.

Any inadequate number of Conductors dangerous.

15th. I proceed now in the attempt to sustain my opinion, that a Magazine with but one or any inadequate number of conductors is in greater danger than if it had none.

16th. The cause of a lightning discharge selecting the conductor is to be traced in the law of electrical induction, which I hope to be pardoned for briefly exposing.

The cloud *a* fig. 11 highly charged with electricity of either kind (let us say *positive*) approaches the earth, and by the approximation causes the natural electricities of the earth (*b*) to separate, and that of the negative kind to accumulate at the surface opposite to the cloud. The intervening particles of air are thrown into a polar state. The cloud is attracted by the earth, the electricity of which becomes most accumulated on the buildings and objects on its surface, in proportion to their degree of conducting power. At length the resistance to the rushing together of the two opposite electricities

Digitized by Google

is overcome, and a discharge by explosion takes place, the best conductor on the earth receiving all the electric discharge *it is capable of conducting in the time* the discharge occupies ; of all such bodies a pointed metallic rod is the most likely to receive a discharge and will lead off the greatest quantity thereof to the earth.

17th. Mr. Daniell has indeed stated, that a pointed bar must cause a silent discharge without explosion.* I am unable to comprehend how Mr. Daniell could have fallen into such a misconception. The whole history of lightning accidents teems with instances of well constructed *pointed* rods having been struck and the points melted. Look at the accident to Mr. Daniell's paper para 9. Mr. Trowers' house for example † The conductor is faulty in its construction and the *flash* was seen to strike it by Dr. Goodeve. But let Mr. Daniell try this simple exprement.

Experimental proof that flashes pass to pointed Conductors.

Let *a* fig. 12 be a Leyden jar; *b* a rod and ball connected with the inner coating, *c c* a rod and ball connected with the outer coating. *b* represents the excited cloud, *c c* the excited surface of the earth. To the ball of *c* apply one branch of a discharging rod *pointed* and then rapidly approach the other *point* to the ball *b*, a hiss is heard for an instant and a loud explosion then ensues. If the points had been brought very *slowly* towards the ball *b*, there would have been nothing more than a silent or at most a hissing discharge. Mr. Daniell will perhaps admit, that it is the same thing that the earth carrying the conductor should approach to the cloud, or the cloud approach to the earth, and he will see in this experiment that it is simply the degree of velocity of the approach that governs the nature of the discharge. The electric cloud in a calm atmosphere will give off a constant and quiet stream to the rod, but let the cloud be driven onwards before the wind, or drawn within the vortex of mechanical electrical attraction, and then *explosion will inevitably ensue.*

18th. So much for the cause and nature of the direct lightning *flash to a single pointed conductor,* let me beg the Board to honor me with their attention to this distinction. It is essential that no misconception should arise.

* A pointed conductor will indeed draw off silently and safely a considerable portion of electricity from a charged cloud, but it can possess no power of determining a disruptive and destructive discharge at a point where it would not otherwise occur.

† Described in my first report.

Digitized by Google

The flash may be greater than one conductor can convey.

19th. An explosion then it must be admitted may occur to a pointed conductor, I have next to show that this explosion, or the flash, or the quantity of the electricity passing (which I use as convertible terms) may be so much greater in quantity than the single conductor can convey *in the time* of the discharge, that a considerable part, nay the whole of the excess, must pass to the adjacent object. To make my meaning clearer—Let us suppose the cloud to be charged with 1000 parts of active electric matter, let us *assume* the conducting power of a lightning rod to be equal to 250 *in an unit of time.* I believe that the 750 parts in excess, will in the same unit or instant pass off in every direction to surrounding objects, striking those which offer it the least conducting part.

Proof in the accident to Dr. Goodeve's house.

20th. In proof of this assertion I refer to the accident to Dr. Goodeve's house which I have already reported. Dr. Goodeve's house is 20 feet from Mr. Trowers; Dr. Goodeve while walking in his verandah saw the lightning strike Mr. Trowers' conductor, and at the same time strike his own house, taking as might be anticipated the window bolts and other metallic bars in its course.

Proof in Mr. Raven's house Carolina.

21st. Let me cite another and a most important fact from Mr. Arago's collection. The house of Mr. Raven in Carolina was provided with a conductor of an iron bar fixed in the roof, a brass wire outside the wall thence led to another metal bar planted in the earth, the conductor was struck by lightning, the wire was melted as far as the ground floor, the lightning then pierced the masonry of the wall at a right angle, exactly where a gun was standing against the wall in the kitchen. The barrel was struck but uninjured, the stock broken, and thence the electric matter passed to the ground.

The last accident further considered.

22d. Here we have clearly lateral deviation from a conductor *and the excess passing to the nearest conducting object.* The wire was disproportionately small for the quantity of the discharge, it was fused, and the excess passed into the adjacent conductor. It will be objected that this would not have happened, had the lightning rod or wire been of the ordinary dimensions—that the conductor would not have been

Digitized by Google

fused and the lightning would not have left it: in reply I point once more to Dr. Goodeve's house, Mr. Trowers' conductor was not melted and yet Dr. Goodeve's house was simultaneously struck.

Accident to the frigate *La Junon*.

23d. Look to another fact cited by Arago. A French vessel of war *La Junon*, was running before a brisk gale, a copper conductor of twisted wires lead from the main mast head to windward, and was secured by copper strips to the ship's side, a flash strikes the top, and a flash is seen by all on board *at the same instant*, to leave the conductor about on a level with the cap of the main mast, and to dart into the water over the *lee* bulwark. This is a clear instance of an excess of electricity leaving a conductor through which it cannot force an instantaneous passage: all that the conductor could convey was borne off to windward, the rest opened to itself another less difficult passage.

What is the greatest mass of metal a flash can fuze.

24th. It might here be a most appropriate place to discuss the question, what is the greatest mass of metal a flash of lightning can fuze, when we remember that the surface of a cylinder increases by a simple multiple of the diameter, while the mass increases as the square, that every fact shews it to be the surface which the electricity, pursues,* while its calorific effect must be in the inverse proportion to the mass, it will probably seem that the surface may be inadequate to convey a quantity of electricity, although this be insufficient to melt or even to heat the whole mass of the metal.

A flash may be too great for the surface to convey and at the same time too small to melt the whole mass.

Do conductors attract lightning.

25th. Mr. Daniell in reference to the inefficiency of single conductors, enters on the much vexed question as to whether they *attract* lightning, or are merely passive conductors for its conveyance. He takes the latter view, declares the

* Mr. Harris, a high authority on electricity, makes these remarks respecting the surface action of conductors.

"The conducting power of a metallic rod has but little relation to its solid contents but is principally dependent on its surface, from which cause the mere gilding of a ball of wood is found to conduct a proportional electrical discharge with the same facility as if the ball was a solid mass of metal, hence a less quantity of metal formed into a hollow tube would be as a conductor, even more effectual than a solid rod of the same diameter, because its superficies would be increased."

Digitized by Google

former to be absurd* and compares the conductor to a water-course, a favourite illustration of his, as it occurs in more than one part of his published writings, practically it is but of little consequence whether the conductor be active or passive. But of all the substances excited at the moment engaged in the vast induction we have described, of the cloud, the air, the earth and the things on its surface, the lightning rod is that in which the induction is the most powerful, and towards which the explosion is therefore the most likely to occur, call it passive if Mr. Daniell so pleases, but the electric fluid is more active in it than any where else. The discharge takes place, the first instalment, or the head of the column rushing to the point of the conductor, heats the air through which it passes, rarefies it, diminishes the resistance to the outpouring of the rest of the electric accumulation. The excess unable in a *unit of time* to pass over the bar, rushes to surrounding objects.† Did it occur to Mr. Daniell that no prudent man builds his house by preference on the bank of a *mountain* water-course. The water-course is doubtless *passive* and it will quietly and silently carry off the stream of an ordinary shower, but the rains may sometimes fall in excess, the stream swells to a torrent. As the waters require

* *Harris on electrical conductors. p.* 31.

The Board are referred to the marginal note at para 17 for Mr. Daniell's own admissions, that pointed conductors draw off a considerable portion of electricity &c. *Drawing* off and attracting are very like synonymous terms.

† The Board are requested to consider Mr. Faraday's opinion on this point.

The fact however is, that disruptive discharge is favorable to itself. It is at the outset a case of tottering equilibrium and if time be an element in the discharge, in however minute a proportion, then the *commencement of the act at any point favors its continuance* and increase, and portions of power will be discharged *by a course which otherwise they would not have taken.*

The true heating and expansion of the air itself by the first portion of electricity which passes, must have a great influence in producing this result.

As to the result itself we see its effect in every electric spark, for it is not the whole quantity which passes that determines the discharge, but merely that small portion of force which brings the deciding molecule up to its maximum tension, that when its forces are subverted and discharge begins, *all the rest passes by the same course* from the influence of the favoring circumstances just referred to, and whether it be the electricity on a square inch or a thousand square inches of charged glass, the discharge is complete. Hereafter we shall find the influence of this effect in the formation of brushes, or it is not impossible that we may trace it producing the jagged spark and forked lightning. *Faraday's Experimental Researches.*

Digitized by Google

a given time for the flow of a certain quantity, the excess inundates the bank and the house is overwhelmed. The parallel seems to me to be complete, although Mr. Daniell's ingenuity may probably succeed in placing the question in a different and less intelligible manner.

Mr. Daniell's inexperience in thunder-storms.

26th. With very great respect for Mr. Daniell's acquirements, I cannot help wishing he had the opportunity of increasing his practical knowledge by observing a tropical storm. Had he seen the whole horizon one dense mass of electric clouds, had he heard crash after crash a hundred times repeated like the broadside of a line-of-battle ship, had he seen the lightning strike (as I have) three times within a few seconds, and not a hundred feet from my house, had he been in a storm in which 31 persons perished, he would very probably participate in my idea, that electrical accumulation very commonly surpasses the conveying power of ordinary conductors, and the consequence might be as apparent to his mind as to mine, that the excess must pass to the most adjacent objects.

27th. These facts appear to me sufficient to warrant my opinion, that there is more danger in giving one conductor to a Magazine than in leaving it unprovided altogether. It appears to me further, as I have already stated, that even from any number of conductors, there is another source of danger in what I term the "*lateral discharges*," unless the conductors be placed at a considerable distance from the Magazine.

The lateral discharge.

28th. As much controversy has arisen regarding this *lateral discharge*, I wish to explain clearly the meaning I attach to the term. If this be patiently considered I think it will be found, that it is more about the fitness of words than the nature of the facts, that the difference of opinions exist.

Defined and explained

29th. I select an experiment with the Leyden bottle to exemplify my statement.

Let *a* fig. 13 be a ball and wire connected with the inner coating, *b b* with the outer coating of a charged bottle, let *c* be a metallic ball placed near, but not touching the rod *b*. When the discharge is made by bringing *a* and *b* into contact, by means of the moveable rod *d*, as the electricity passes thro' the rod *b*, a spark takes place between it and the ball *c*, although the ball *c* is out of the direct circuit.

Digitized by Google

Miscellaneous.

Doctor O'Shaughnessy on Lightning Conductors.

fig. 11.

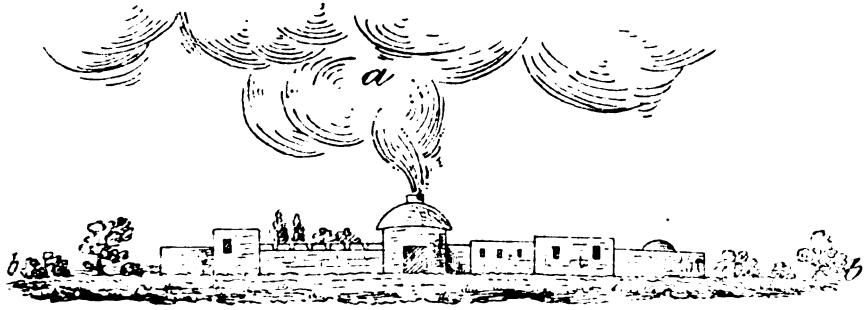


fig. 12.

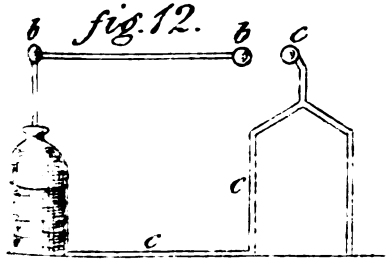


fig. 13.

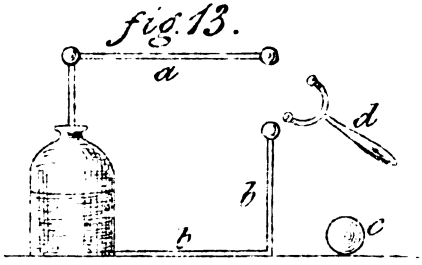
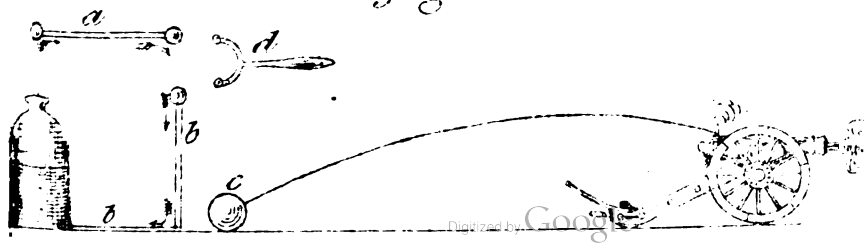


fig. 14.



Digitized by Google

Digitized by Google

30th. This spark all electricians have seen : *its existence is universally admitted.* The ball *c* may be connected with the ground, or with a long wire, and the spark will still pass. If the ball be connected with a wire and the opposite end of the wire with the apparatus called " Voltas Cannon" charged with inflammable air, *at the instant* of connecting the outer and inner coatings or discharging the jar, the cannon is exploded also. Fig. 14.

Gunpowder, spirits, and other inflammable matters, may be fired by this spark, although it is manifestly far out of the *course of the main discharge* shewn by the arrows in the figure.

Opinion of Electricians regarding this Spark.

31st. There have been several attempts to explain the occurrence of this spark. The older electricians and Henry of New York, regard it as the effect of induction in the bodies adjacent to the main conductor, that it is not a direct emanation of electricity from the conductor to the lateral objects. Mr. Daniell says, it is only the excess from *an insufficient conductor* which passes to the adjacent object. This idea any one possessed of a Leyden jar and few pieces of wire may set aside by a simple experiment, when he will find the success of each attempt at obtaining the lateral spark increased by increasing the mass of the prime conductor. Mr. Faraday however, supposed this extra spark to be a direct expansion of the electricity, that with a good lightning rod it can be but small, and then not to badly conducting matter, as wood or stone, but only to neighbouring masses of good conducting matter as the metals which either ought not to be there, or if there, be in metallic connection with the conductor.

Henry's.

Daniell's how disproved.

Faraday's.

32d. On this I will only observe, that the spark now alluded to, whatever be its cause or nature, may be expected to increase in power in direct proportion to the quantity of electricity in the original flash. If with a quart Leyden jar we can procure, as I have repeatedly done, a secondary or lateral spark half an inch long capable of inflaming gasses and gunpowder, I think I am not straining the inference too far when I believe, that the discharge of 10.000 acres of excited cloud may cause a secondary spark or flash capable of passing through the wall of a Magazine and ex-

Remarks on Faraday's opinion.

Digitized by Google

ploding its contents.* The Magazine moreover contains powder barrels lined with copper, and even though no flash or spark pass through the wall, the barrels themselves may give spark to each other under the influence of the electricity passing outside. Mr. Faraday has shewn in one of the most perfect of all his matchless researches, that without the direct conveyance of electricity, the walls of an apartment in which a common electrifying machine is worked, are in a state of active electrical excitement.

Mr. Harris's opinion.

33d. Mr. Harris who is doubtless a highly accomplished electrician has recently published some views regarding this spark which require a cursory notice. Mr. Harris when *ten years ago* he proposed his system of ship conductors, was either unaware of the occurrence of this spark, or held it in such little respect that he actually led one of his conductors through the after Powder Magazine. Mr. Harris has induced the Lords of the Admiralty to order this system to be adopted throughout the Navy.

Mr. Harris admits the existence of the spark in question.

34th. Mr. Harris admits the existence of the lateral spark, but attributes it to what is commonly called the "residual charge." Thus after discharging a battery it is well known that a small secondary charge collects, and will give a spark or shock to any conductor touching both the coatings.

The existence of the spark the only thing of importance.

35th. I repeat that it is but of little consequence what the *cause* or nature of the spark in question be. It is its *existence only* that should influence this question. But if Mr. Harris will repeat the experiment described at para. 30, he will find the explosion of the cannon to occur *at the very same instant of time* as the discharge of the jar, and that after this, he will still succeed in obtaining the residual discharge on contact of the inner and outer coatings.

* Mr. Harris has indeed recently asserted, that increasing the primary does not increase the secondary one, but I must state with every respect to this Gentleman that I have repeatedly exhibited to my classes long before his paper was published, the experiment described at Para. 30, and that I have often shewn that while success is uncertain with a small jar it is infallible with a large one. I have not the means of measuring the spark, but its increase was plainly visible and palpable as we increased the battery and its charge.

Digitized by Google

36th. The accident which befel the *Rodney* last year in the Mediterranean, shews the occurrence of lateral or extra discharge in a form which scarcely admits of mistake; the flash struck the main-top-gallant-mast and escaped from the mast 7 feet above the deck, and was seen by all on deck to go over the lee netting and strike the sea a short distance from the ship.

Accident to H. M. S. *Rodney* shews lateral sparks.

Sparks were seen by many of the Officers between decks, and many of the men declared they saw balls of fire on the lower deck, and ran after them to throw them out (see Sturgeon's Annals of Electricity, October 1839. Page 166.)

Here is another instance of lateral or indirect effect. At the moment Dr. Goodeve's house was struck, Mr. Hutchins sitting in a room on the ground floor several feet from the course of the lightning received a severe shock.

Lateral shocks in Dr. Goodeve's house.

Whatever produces a shock will in greater quantity cause a spark, and if the spark be but the 10th of an inch in length it can inflame powder, which is the great matter we have to guard against.

37th. In connection with this subject Mr. Arago gives us some very useful hints.

Arago's opinion.

A few detached sentences may be quoted to shew Mr. Arago's ideas " lightning once engaged in a metallic bar of " sufficient dimensions, and well constructed, will not quit it " to strike the materials of which buildings are usually con- " structed, but in *such small quantity* that no *injury can* " *arise*, nor even any appreciable effect."

38th. Mr. Arago is here writing of ordinary buildings, but what would produce no appreciable effect on these, would cause the explosion of a Magazine.

39th. Mr. Arago proceeds to ask, should conductors be placed within or externally to buildings, the Board will see how this bears on Mr. Harris's ship conductor which *runs through the after* Magazine. " I confess" says Mr. Arago " that on this point I would be much less affirmative. Vol- " taire used to say there are some great Lords not to be ap- " proached without extreme precaution, and lightning is " one of them. I think the illustrious author is perfectly

Digitized by Google

" right, especially when I recollect the case of Mr. Raven's " house already alluded to. Doubtless the conductor was " not sufficiently thick, but here is an occurrence in which " all was apparently in good order, the conductors acting as " well as could be desired, and nevertheless there was a " deviation of the electric matter" * * " The 31st July " 1829, at the gaol of Charleston, at the moment of an im-

Lateral discharge in Charleston Gaol.

" mense thunder-clap, 300 persons " received at the same instant a violent " shock, the effects of which lasted for some seconds" * * " The gaol had 3 good conductors 18 feet apart, the build- " ing was untouched by the lightning" * * * (see the *Al-* " *manac* for 1838)"

40th. How did the inmates receive this shock? Mr. Arago refers it to the large quantity of iron the building contained, can I be accused of exaggeration when I express my belief that the same cause which independently of direct discharge occasioned the shocks alluded to, would in a Magazine of powder barrels be sufficient to occasion minute sparks and consequences to which these will naturally lead to.

41st. Lastly, M. Arago alluded to the proposition of Toaldo sanctioned by the Academy of sciences, that for Powder Magazines, the conductor should be placed at two or three metres from the walls, on vertical masts. He approves of the idea in principle, but describes its practical application as too expensive, owing to the number of conductors which would be required.

Henry's most important experiment on sparks from lightning rods conveying electricity.

42nd. But there is one most important experiment by professor Henry of New York, to which I earnestly invite the attention of the Board—I wish my humble voice could reach the Lords of the Admiralty with effect, and that by an appeal to the good sense of men, who have only the public interest at heart, and who have no pledged scientific notions to combat for, that I could induce them to pause before they provide the British Navy with the dangerous conductors Mr. Harris has led them to adopt. Professor Henry led a copper wire 40 feet long from the prime conductor of an electrifying machine, into a deep well full of water, on working the machine, from *every part of this wire* large sparks were obtained, and a Voltas cannon was fired by one of these sparks close to the surface of the water; nay more, Professor Henry repeated this experiment on a lightning conductor attached to a house, and properly constructed in every way, from every part of the conductor sparks were given off.

Digitized by Google

Mr. Faraday's own admission.

43d. But even in the paper by Mr. Faraday, I find ample admissions of many of the facts I have contended for.

"It is no doubt true, that low rounded buildings such as I "understand Powder Magazines to be in India, are but very "little liable to be struck by lightning." * *

"It is also I think very probable, that a lightning conduc- "tor may under certain circumstances cause an electric dis- "charge to take place, where none would have occurred, no "conductor being present."

Mr Daniell's admission.

44th. Let us hear what Mr. Daniell himself is candid enough to allow, see para. 11 of his report.

"There can be no doubt that a conductor at the moment "of a discharge of electricity passing through it, influences "in a degree all good conducting substances in its immedi- "ate vicinity by induction, but no discharge will take place "from it to any neighbouring body, unless it be insufficient "itself to conduct the whole of charge." * * *

Mr. Sturgeon's opinion.

45th. To this I have only to add, that in a paper published since my first report (December 1838) by Mr. Sturgeon in the Annals of Electricity for October 1839, precisely the same view as those I entertain are fully and ably advanced. Mr. Martyn Roberts, a well known Electrician, advocates the same views, such also were the opinions of my admired and esteemed friend James Prinsep, whose name alone is a sterling proof to the Indian Community at least, of the value of the conclusions he arrived at.

Mr. Robert's opinion.

Mr James Prinsep's opinion.

46th. From the consideration of all these facts and reasons, I think myself justified fully in adhering to the opinions expressed in my first report, I do not and never did deny the protecting power of well constructed conductors, erected in a given number.

I stated distinctly all the circumstances from which danger might result, and how I conceived these might best be avoided. I freely admit copper to be superior to iron, but

Digitized by Google

I wished to avoid expence in introducing the system I proposed. On that system I conceive all danger would be obviated, while in the method proposed in the letter from the Hon'ble Court, at least two highly probable causes of accident remain in full operation.

47th. Having obtained through your Board, the sanction of Government to the publication of the papers by Messrs. Faraday and Daniell, I will take care that the views therein contained, shall be generally made known. In an early number of the Journal of the Asiatic Society, I propose further to print an abstract translation of Mr. Arago's remarkable *notice sur le Tonnere*, which I saw for the first time when it was sent to your Board, along with Messrs. Faraday's and Daniell's papers. The interesting facts with which Mr. Arago's memoir abounds, will doubtless lead many competent observers to study the phenomena and effects of lightning on the grand scale, in which they may be witnessed in India. A multitude of facts will doubtless be thus quickly accumulated, and from these we may reasonably hope to found certain opinions on many points still open to doubt and discussion.

48th. The electrical history of Chouringhee, I will take care to collect for Mr. Daniell's gratification, with the precision he is good enough to recommend me to observe. I only regret, that this is not the appropriate place for noticing the very courteous remark he has made upon this point.

49th. I design to forbear from all observations on the attachment of conductors to *ordinary* edifices, whether private or public, no one is more convinced of their value than I am, but I am at the same time as satisfied, that as they are usually constructed, they are sources rather of danger, than of protection. Referring therefore with much respect to my first report, I need only modify the suggestions therein given, to the extent that I believe six to ten feet interval between the walls of the Magazine and the conductor will suffice, instead of the more considerable space 20 *feet*, which I first recommended. With this sole exception I am deeply impressed with the belief, that it were wiser to commit our Magazines to the same chances through which they have passed unarmed for the half century, than expose them to the

Digitized by Google

possible dangers I have ascribed to proceed from the attachment, in the ordinary manner, of an inadequate number of conductors, erected at but one foot from their walls.

50th. To economise materials, it would be advisable to erect a wall as high as the roof of the Magazine ten feet distant from it all round; at each corner of this wall, a conductor twenty feet higher than the roof, and properly led to the ground as deep as the water level, should be placed. Between these conductors at every ten or fifteen feet I would fix a pointed bar six feet long, inclining outward at an angle of 45°, all these bars should be connected at their bases with the corner conductors, by a broad strip of sheet copper led along the wall.

Letter from W. B. O'Shaughnessy, Esq. m. d. *Assistant Surgeon, to Captain DeBude, Officiating Secretary to the Military Board, dated Calcutta, 11th September* 1840.

I have the honor to enclose for submission to the Military Board, a printed copy of some remarks on an error of measurement in my letter on lightning conductors. I am happy to add, that the error does not at all affect the inferences I drew from all the facts before me, as to the protection of our Powder Magazines.

It gives me regret to have to point out a serious error in my account of the accident by lightning which occurred to Dr. Goodeve's house, in May 1837. The distance from Mr. Trowers' conductor, which was struck at the same instant, is *twenty-two yards*, instead of twenty feet as stated in my report.

The error was occasioned by my entrusting the measurement to a native assistant, who no doubt either contented himself by a guess, or unknowingly used the word *feet* instead of *yards* in his report. Illness prevented my making the measurement myself. Fortunately however, the error does not in the least degree vitiate the argument in which the accident was mentioned for illustration's sake alone, that the best conductor will not protect a radius of 60 feet (as

Digitized by Google

Biot has assumed it would) is now proved by the history of so many lightning explosions, that an error in one, is of no importance whatever. The reader will find in paras. 10 11-12-13 and 14 of my second report sufficient facts to set this question at rest for ever.

My chief object in noticing the accident to Dr. Goodeve's house, was to shew that one and the same explosion may fall on a conductor and also on other adjacent bodies, that is, that one conductor may not be capable of carrying off the whole of the electricity of a single flash, although the conductor remain unmelted, or even be not perceptibly altered by the heat of the discharge. This view is but strengthened by the occurrence as it now stands in the corrected account, the greater the distance the more remarkable is it, that the primary flash should have been subdivided as in this instance. Let it be remembered that Dr. Goodeve saw the flash strike both objects at the same instant.

I congratulate Mr. Daniell on an occasion thus afforded to him, for a further display of the peculiar tone and temper which characterized his first report, but I repeat here distinctly, that the error into which I have been led, does not in the slightest degree affect the inference which all the facts recorded, manifestly lead to—1st, that a conductor however well constructed, does not infallibly protect a space of sixty feet radius ; 2d, that a flash of lightning may strike a conductor, and other adjacent objects, at the same instant. The occurrence at Dr. Goodeve's house has nothing to do with the discussion regarding the "*lateral discharge*," and had the accident never taken place, the arguments I advance would not be in the least degree affected. One good effect will at all events proceed from this mistake, that I shall never again depend on the measurements made by persons who do not understand the object in view, and the necessity for care in their performance of so simple a task.

Digitized by Google

REFERENCES TO A PLAN, FIG. 15, OF ATTACK ON THE FORTS OF CHUENPEE AND TY-COCK-TOW IN THE BOGUE.—7TH JANUARY 1841.

a.—Large Fort, its guns raking every ship coming up the river.

b.—60 Gun Fort with line of Battery nearly meeting the opposite line of Fort,

c.—of more than 100 Guns. } Battery of 24 Pounders.

d.—Round uniform mountain.

e.—25 Gun Fort. } on north Wang-Tong island.
f.—20 Gun Fort. }

g.—Tower with wall on each side to East and West Forts, on North Wang-Tong.

h.—South Wang-Tong with house on top—no Forts.

i.—Passage to West of Wang-Tong Islands, dotted and marked "Deep Water" sufficient for the 74 gun Ships to avoid the Anung Hoy Forts.

k.—Position of the Fleet.

l.—Ty-Cock-Tow Fort battered down on the 7th January 1841, by H. M. Ships *Columbine* 18, *Samarang* 28, *Modeste* 18, and *Druid* 44, 13 Chinese killed, many wounded and fled—lasted nearly an hour. *Samarang* having one shot passing right through her, rigging cut a little, no English killed.

m.—Point of landing nearly 1400 Troops—Royal Artillery with 2 guns, 26th Cameronians, 18th Royal Irish, Royal Marines, 37th Madras N. I. and Bengal Volunteers.

n.—Point where, on the Troops rounding the Hill after landing received the Chinese fire from the valley stockade.

o.—Hills over which the Skirmishers extended to cut off the Chinese retreat along the valley to the creek.

p.—Battery of 4 Guns facing Anson's Bay, and protecting the base of the hill.

q.—Valley in which the Troops were halted during the shelling and cannonading the Tower.

r.—Point from whence *Nemesis* and *Queen* commenced shelling Chuenpee Tower.

s.—Hill from which the Artillery with 1 Howitzer and 1, 9-Pounder cannonaded the Tower

t.—Stockade with deep ditch, embrasures, and guns, scouring the valley towards,

u.—A Traverse in front of *t.*—with embrasures but no guns, one end terminated by a 3 gun Battery commanding the valley *q.*

v.—High bank enclosing bamboo houses, ditch exterior, 3 guns at Eastern extremity running up the Tower hill about 40 yards below the top.

Digitized by Google

w.—Chuenpee Tower on a height 10 guns.

x.—Valley in which the Troops collected after the Action.

y.—Tents pitched in the Valley.

z.—Breast-work of sand bags facing Anson's Bay.

A.—Battery of 4 guns on the descent from the Tower, to

B.—the lower Fort of 17 guns on its River front, 4 or 5 in rear, with

C.—Its only gate towards Anson's Bay.

D.—Hill covered with Fir Trees.

E.—Below Southern Anung Hoy Fort.—Bluff Point under which the *Nemesis* commenced her enfilade fire upon the Fort with shot, shells and rockets, on the morning of the 8th.

†† In Anson's Bay denoting the Junks lying there on the 7th destroyed by the 3 Steamers—*Nemesis, Queen* and *Enterprise*—Chinese Admiral's Junk blown up, himself wounded in the knee but escaped with loss of his cap.—In all 11 Junks destroyed,—1 blown up with its whole crew supposed at least 50 men, probably more than 100.

..... Dotted lines—Distances, figures for miles and fractional parts.

N.B. Killed at Chuenpee about 3 or 400 Chinese.—No English.

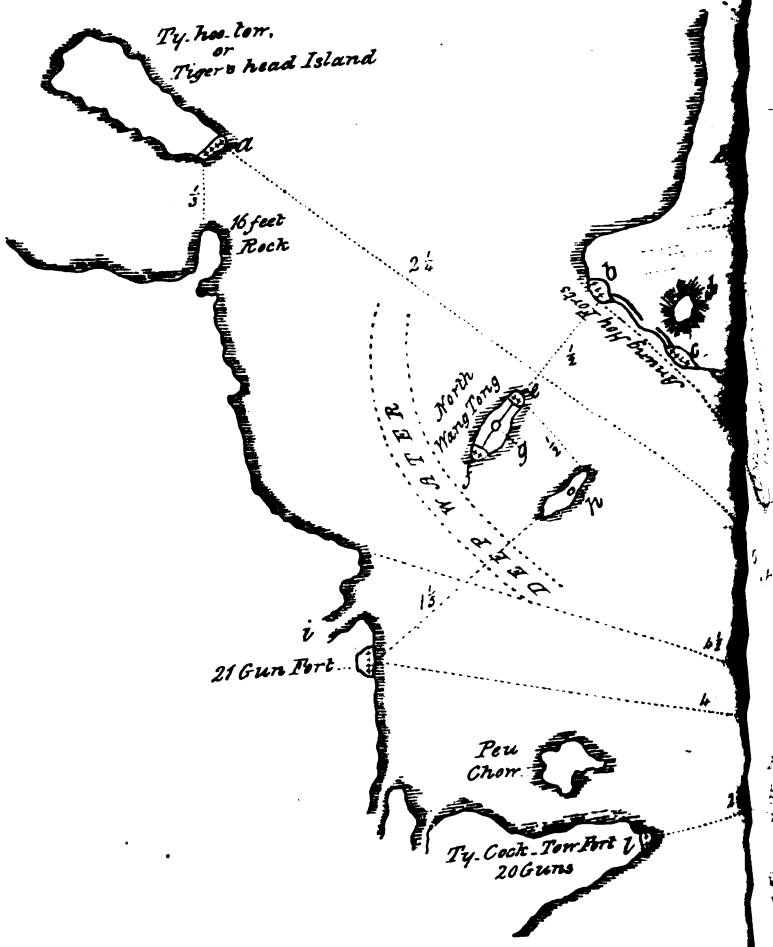
Digitized by Google

Digitized by Google

Misc

Plan of the Attack on the Chu
7th and 8

Macao bearing S
Canton ..... " ..... N



Artillery Depot
1841

Digitized by Google

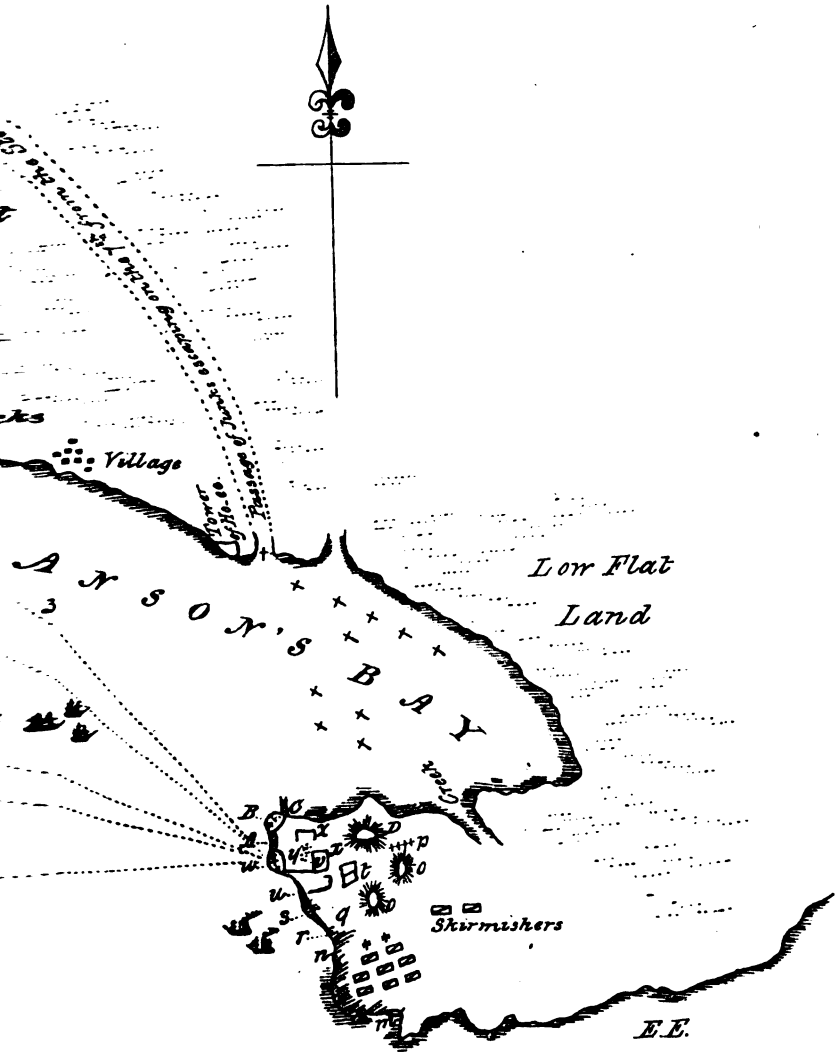
laneous. *fig. 15.*

ee and Ty-Cock-Tow Forts in the Bogue

enuary 1841.

26 Miles distance.

32 ..... " ..... " .....



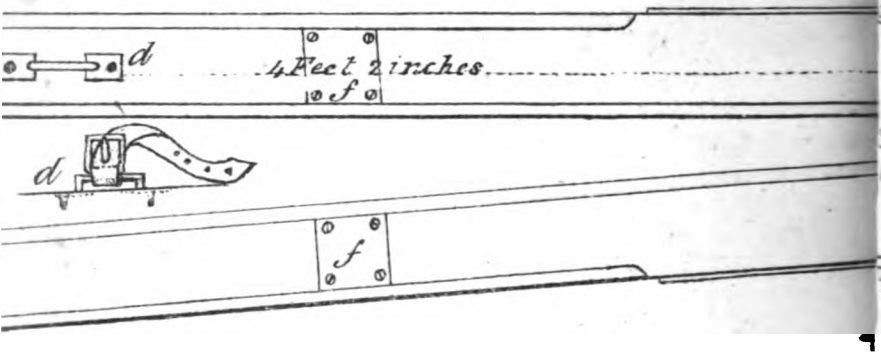
Digitized by Google

Digitized by Google

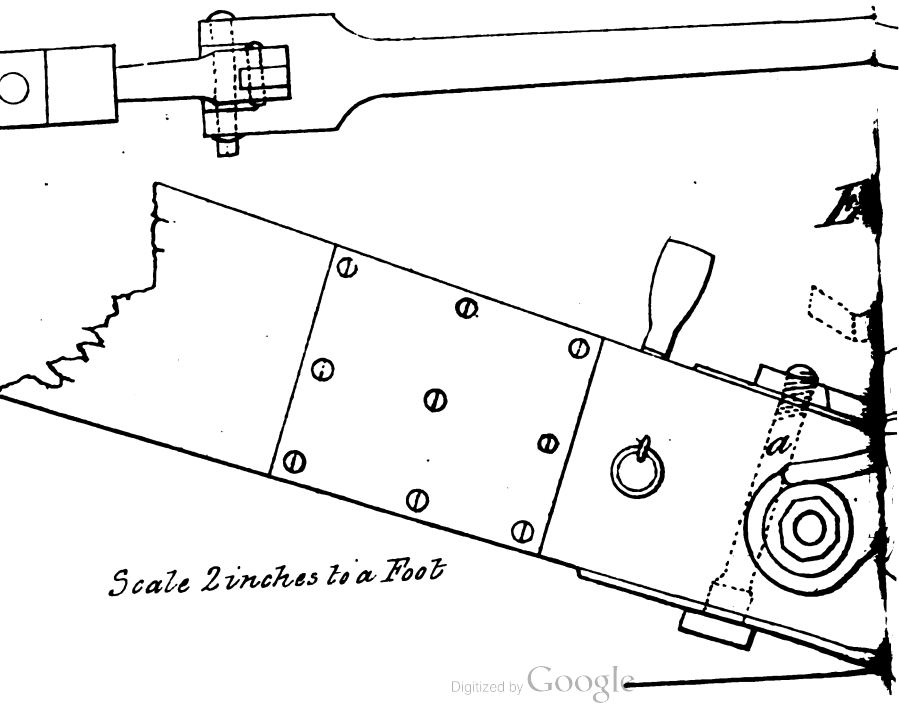
Digitized by Google

Miscell

Method of adapting t to the present



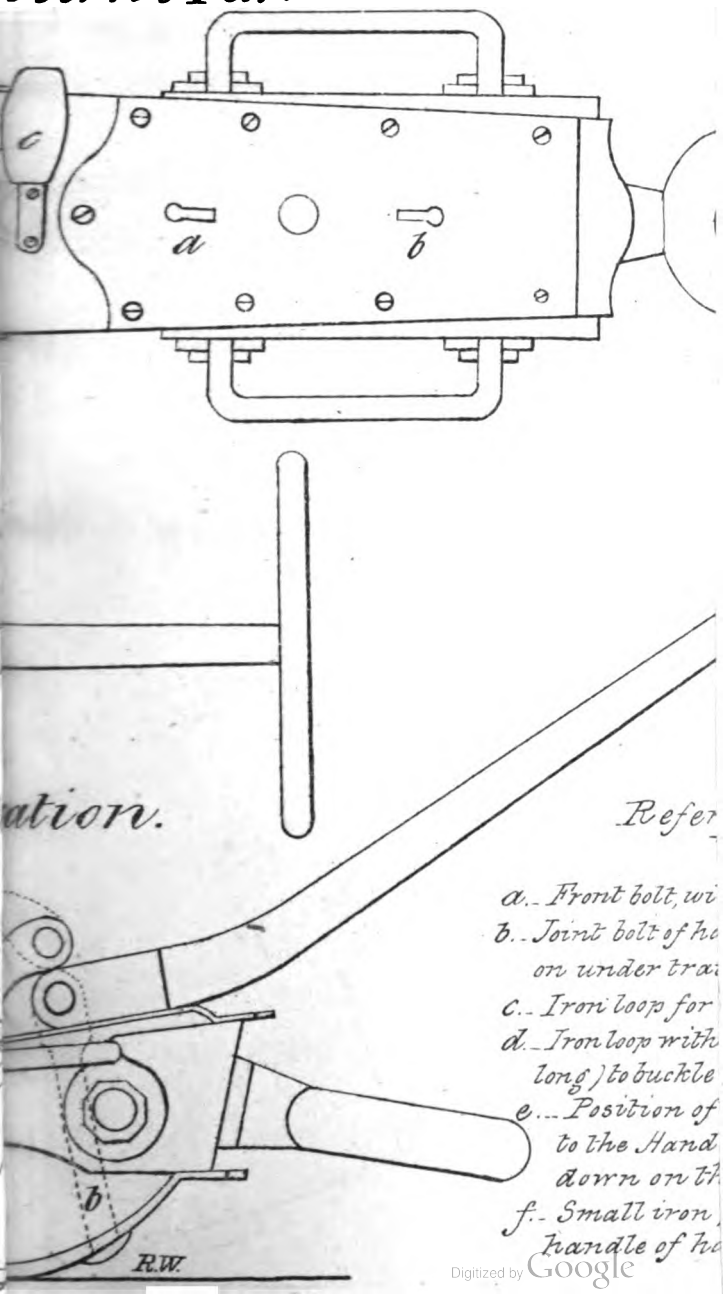
Plan of Handspik



Digitized by Google

...neous.

... new Iron Handspike
...ttern 6 Pdr.



...ation.

Refer

a.- Front bolt, wi
b.- Joint bolt of he
on under trai
c.- Iron loop for
d.- Iron loop with
long) to buckle
e.... Position of
to the Hand
down on th
f.- Small iron
handle of he

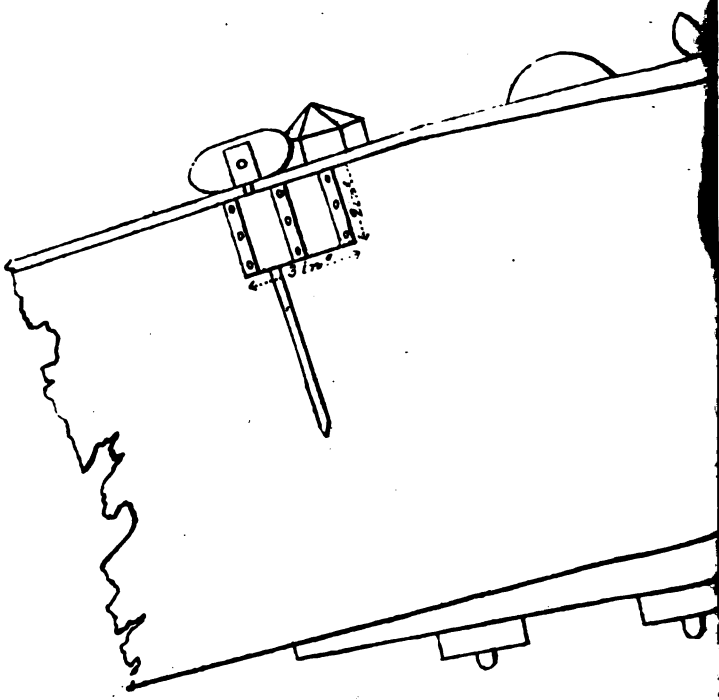
Digitized by Google

Digitized by Google

Digitized by Google

Misc

Sketch shewing the positi
Loop of Buffaloe hide for
rows of tacks, having a str



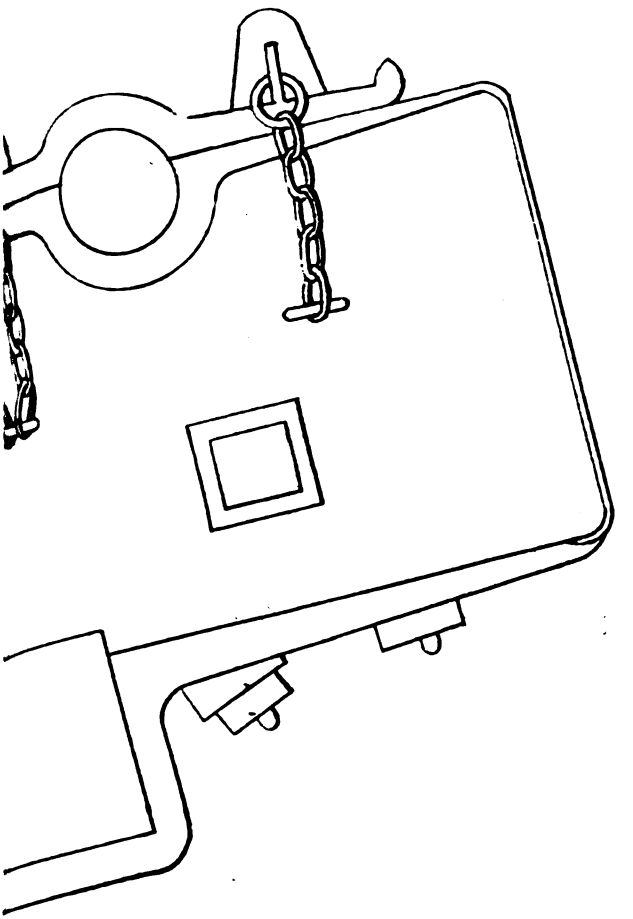
N.B. The above shews th
for the 12 Pounder
of the rose head 3

Digitized by Google

neous

fig. 17

dimensions of the leather
the Pricker, there are three
ther under the heads



n of the loop for 9 and 6 Pounders,
the loop must be placed in front

Digitized by Google

Digitized by Google

A SHORT DESCRIPTION OF THE FORT OF NEPAUNEE IN THE SOUTHERN MAHRATTA COUNTRY—By Capt. F. BURGOYNE.—*Fig.* 18.

The Fort of Nepaunee is generally considered one of the strongest in the Southern Mahratta Country, having not many years ago been added to, and strengthened considerably.

It consists of a palace, surrounded by a strong octagonal mud fortification, having eight high mud bastions, capable of holding two or three pieces of Ordnance, they are circular.

The curtains between these bastions are not of sufficient width to allow of guns being used, but are well calculated for musquetry—This mud fort is again entirely surrounded by a high rampart with parapet of no great width, the escarp of this work is revêted with masonry, of very great strength and solidity; the height of the parapet from the water in the ditch is 39 feet, the depth of the ditch varies from 7 to 15 feet, and the breadth I should think about 30 feet.

The counterscarp is also revêted with strong masonry, and of a height proportioned to the escarp—there is a covered way round the ditch, with a high glacis, which though covering the works very effectually, yet affords shelter for Troops at the foot of it, from its great steepness.

The gateway (only one) and its defences are all of strong stone work. The first gate is after passing the bridge over the ditch, and opens direct into the space between the mud fort or keep, and the outer rampart—the gate is well flanked by parapets which are all loop holed. The second gate opens direct into the mud fort, and is some distance from the first gate, the approach to the 2d gate is flanked all the way up to it, by the mud fort, and the gate itself is of great strength.

Outside of the gateway facing the pettah, is an outwork on the glacis, it consists of a low circular wall, in which one or two pieces of Ordnance might be used, but on the day of the attack the guns were placed outside of the work on the glacis, this outwork is of use as a defence to the entrance to the gate.

Digitized by Google

RETURN *of* **ORDNANCE** *captured at the Siege of Nepaunee on the 21st February* 1841, *by a Field Force under the Command of Major* VIVIAN.

Number.	Ordnance.	Description of Metal.	Diameter of Bore. Ins.	10ths.	Length of Metal. feet.	Ins.	Description of Chamber.	Depth of Chamber. Ins.	10ths.	Supposed Weight. cwt.	qrs.	lbs	Manufacture.	Whether with or without Bed or Carriage.	Remarks.
1	Mortar	Brass	8	0	1	6	Spherical....	7	5	4	0	0	Native	Without Bed	
2	Howitzer ...	"	11	0	2	9	Double	8†	5	7	0	0	"	Do. Carriage	† Inner. * Outer.
								8*	0						
3	" ..	"	11	0	2	9	"	as No. 2		7	0	0	"	"	
4	" ...	"	13	0	2	7½	Spherical....	13	0	10	0	0	"	"	No vent.
5	" ...	"	12	0	2	7½	"	12	0	10	0	0	"	"	
6	" ...	"	7	8	3	2½	"	11	0	6	0	0	"	"	
7	" ...	"	7	8	3	2½	"	11	0	6	0	0	"	"	
8	Gun ...	"	3	0	8	4	.....	....	.....	8	0	0	"	"	
9	" ...	"	3	0	8	4	.....	....	.....	8	0	0	"	"	
10	" ...	"	3	5	7	6	.....	....	.....	9	0	0	"	"	
11	" ..	"	3	5	7	6	.....	....	.....	9	0	0	"	"	Vent run.
12	" ..	"	3	4	4	5	.....	...	.....	5	0	0	"	"	
13	" ...	"	3	4	4	5	.....	....	.....	5	0	0	"	"	
14	" ...	"	3	6	4	5	.....	....	.....	5	0	0	"	"	Vent run.
15	" ...	"	3	4	5	11	.....	...	.....	7	0	0	"	"	
16	" ..	"	3	4	5	11	.....	...	.....	7	0	0	"	"	
17	" ...	"	4	0	6	2	.....	...	.....	9	0	0	"	"	

Digitized by Google

Number.	Ordnance.	Description of Metal.	Diameter of Bore. Ins.	10th.	Length of Metal. feet.	ins.	Supposed Weight. Cwt.	qrs.	lbs.	Manufacture.	Whether with or without Carriage, &c.	Remarks.
18	Gun ...	Brass	4	2	8	7	13	0	0	Native	Without Car.	
19	„ ..	„	4	2	8	7	13	0	0	„	With „	Carriage very old and useless.
20	„ ..	„	3	4	4	7	6	0	0	„	„ „	Used in defence.
21	„ ...	„	2	2	4	9	1	2	0	„	Without „	
22	„ ...	„	2	4	4	9	1	2	0	„	„ „	Iron trunnions.
23	„ ...	„	3	2	3	10	4	2	0	„	„ „	
24	„ ...	Iron	3	2	2	6	0	3	0	„	„ „	Wall piece.
25	Gingall ...	„	1	5	2	0	0	1	0	„	„ „	
26	Gun ...	„	4	5	5	5	12	0	0	„	„ swivel std.	
27	„ ...	„	4	0	5	3	12	0	0	English	„ Carriage	Vent run, and one Trunnion gone, Company's mark, wrought iron.
28	Carronade ...	„	4	3	4	0	10	0	0	„	„ „	
29	„ ...	„	4	2	4	2	8	0	0	French	„ „	
30	Gingall ..	„	1	5	2	0	0	1	0	„	„ „	
31	Gun ...	Brass	4	4	6	2	8	0	0	Native	„ „	
32	„ ...	Iron	4	7	7	7	11	0	0	Indian	With „	These guns were in position on the Glacis, the Carriages were very old, and were broken down in action.
33	„ ...	„	5	1	7	2	11	0	0	English	„ „	
34	„ ...	Brass	3	1	4	10	9	0	0	„	„ „	
35	„ ...	„	3	8	4	10	9	0	0	Indian	Without „	
36	„ ..	„	3	5	6	1	5	1	0	„	„ „	

Digitized by Google

Return of Ordnance, &c. continued.

37	Gun ..	Brass	5	7	9	11	10	0	0	Danish	Without Car.	
38	„ ...	„	4	0	4	8	7	0	0	Native	„ „	
39	„ ...	„	4	0	4	8	7	0	0	„	„ „	
40	„ ...	„	4	1	6	0	9	0	0	„	„ „	
41	„ ...	„	4	1	6	0	9	0	0	„	„ „	
42	„ ...	„	4	8	11	10	10	0	0	„	„ „	Unfinished.
43	„ ...	„	3	0	3	11	6	0	0	„	„ „	Very old.
44	„ ...	Iron	4	0	4	4	7	0	0	„	„ „	Used in action. Muzzle broken.
45	Gingall ...	„	1	5	2	0	0	1	0	„	Swivel stand	
46	„ ...	„	1	5	2	0	0	1	0	„	„ „	
47	„ ...	Brass	2	0	3	3	1	4	0	„	„ „	
48	Gun ...	Iron	3	0	4	7	1	3	0	„	„ „	
49	Wall piece...	„	2	2	2	6	0	3	0	„	„ „	
50	„ „ ...	„	2	2	2	6	0	3	0	„	„ „	
51	Gun ...	Brass	3	3	4	6	5	0	0	„	With new Car.	Used in action.
52	„ ...	„	2	7	8	6	7	0	0	„	Carriage	Dismounted in action.
53	„ ..	„	3	7	4	8	5	0	0	„	With Carriage	Used in defence.
54	„ ...	Iron	4	0	6	1	6	0	0	„	Without „	
55	„ ...	Brass	2	0	3	10	1	1	0	„	„ „	
56	„ ...	„	2	6	8	5	4	0	0	„	With new „	

These Guns are all unserviceable, though some of them were made useful in the defence, by the Garrison. The Metal appears to be of a superior description to what I have seen in other Native Ordnance.

CAMP AT NEPAUNEE :
February 22d, 1841.

(Signed) F. BURGOYNE, Captain,
Commanding Artillery with the late Nepaunee Field Force.

Digitized by Google

Digitized by Google

References.

a, a. Positions held by the Enemy previous to the Attack.

b..... Position of Gun, and Infantry attacking the outwork a

c c c.... Enclosure occupied by the Gun and Infantry after driving the Enemy into the Fort.

d..... Guard Room occupied by the Rifles when the Enemy were driven in.

e..... Battery of the Enemy's, which was taken and dismounted.

f f f.... Party advancing to the Attack.

g g g.. Pettah.

h..... Cattle Shed, where the Jemadar and 5 men were killed by a Shell.

D to d.. about 160 feet.

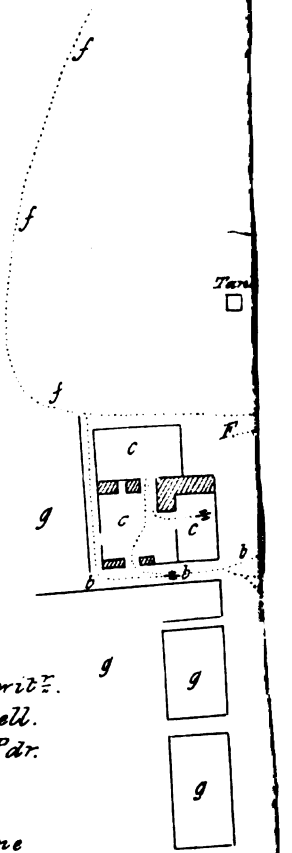
D to c c..... " ...100 yards.

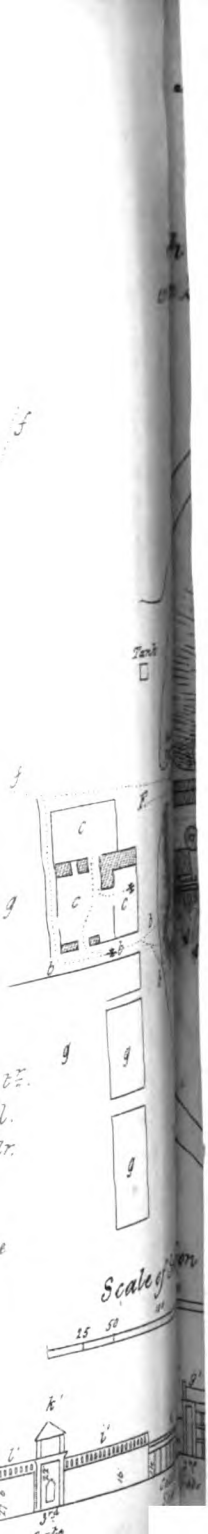
Bastion 5... a Gun dismounted by the Howitr.

... " .....6..... " ..... " ..... " ... a Shell.

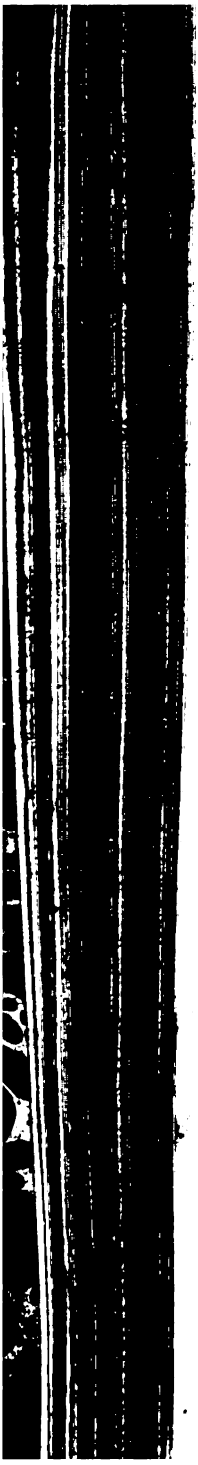
... " .....8..... " ..... " ..... " ... the 9 Pdr. in the enclosure.

N.B The Glacis very imperfect. The 1st and 2nd Gateways alone fitted with Gates, the 1st (or f') very strong.





Digitized by Google



a, a.

b.....

c. c. c.

d.....

e.....

f. f. f.

g. g. g.

h.....

D to C

D to C.

Bast

.....

.....

N.

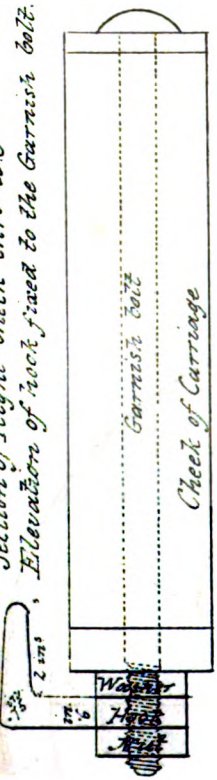
Digitized by Google

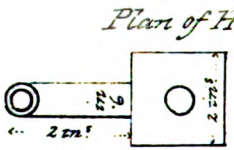
Digitized by Google

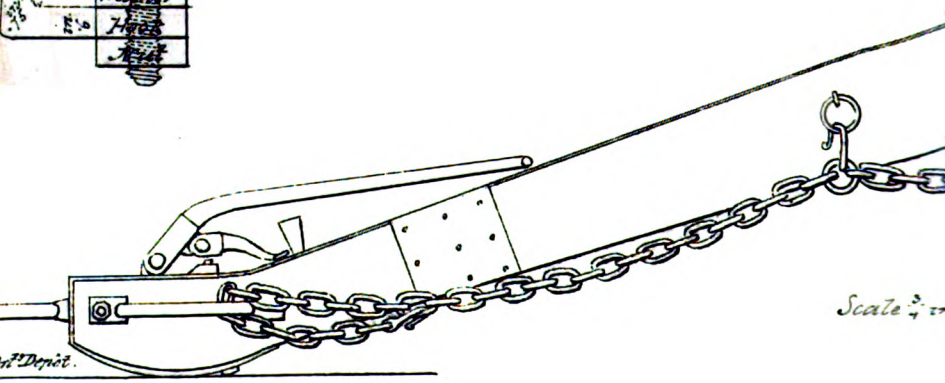
Miscé

Method of carry

Light Fie







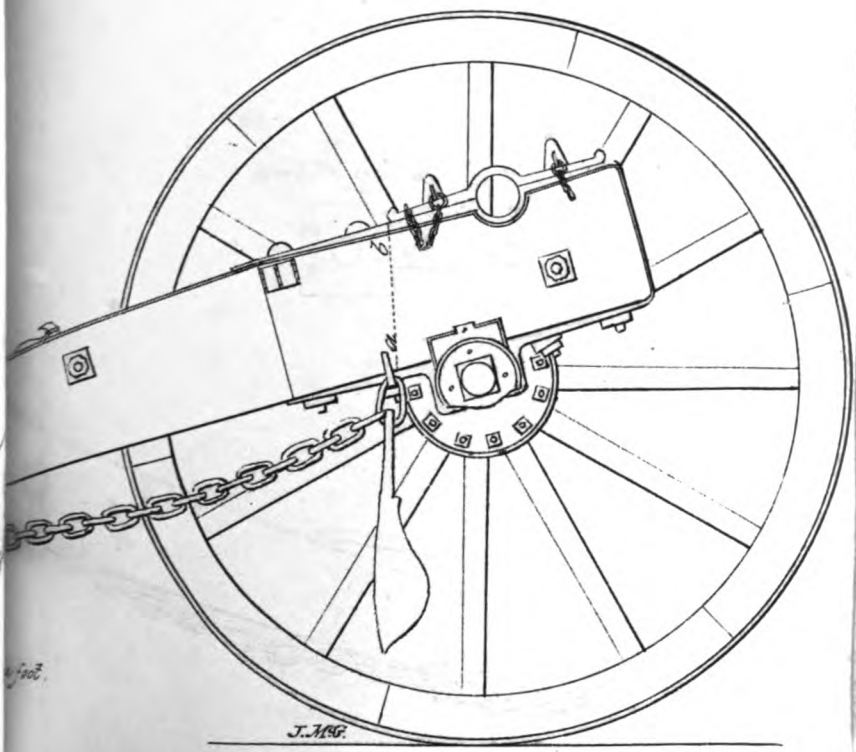
Digitized by Google

neous

fig. 18

Drags or Shoes

Carriages.

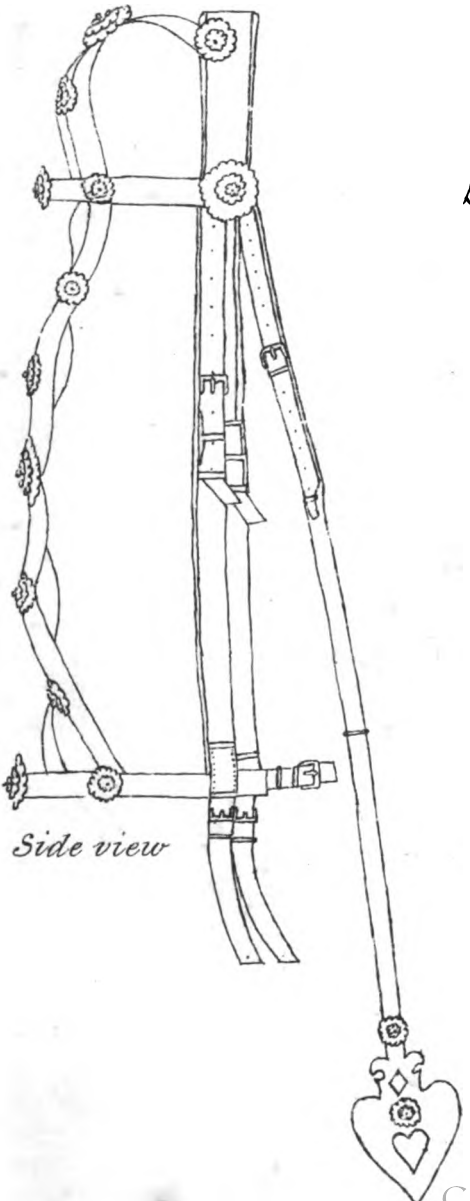


Digitized by Google

Digitized by Google

Digitized by Google

F



Side view

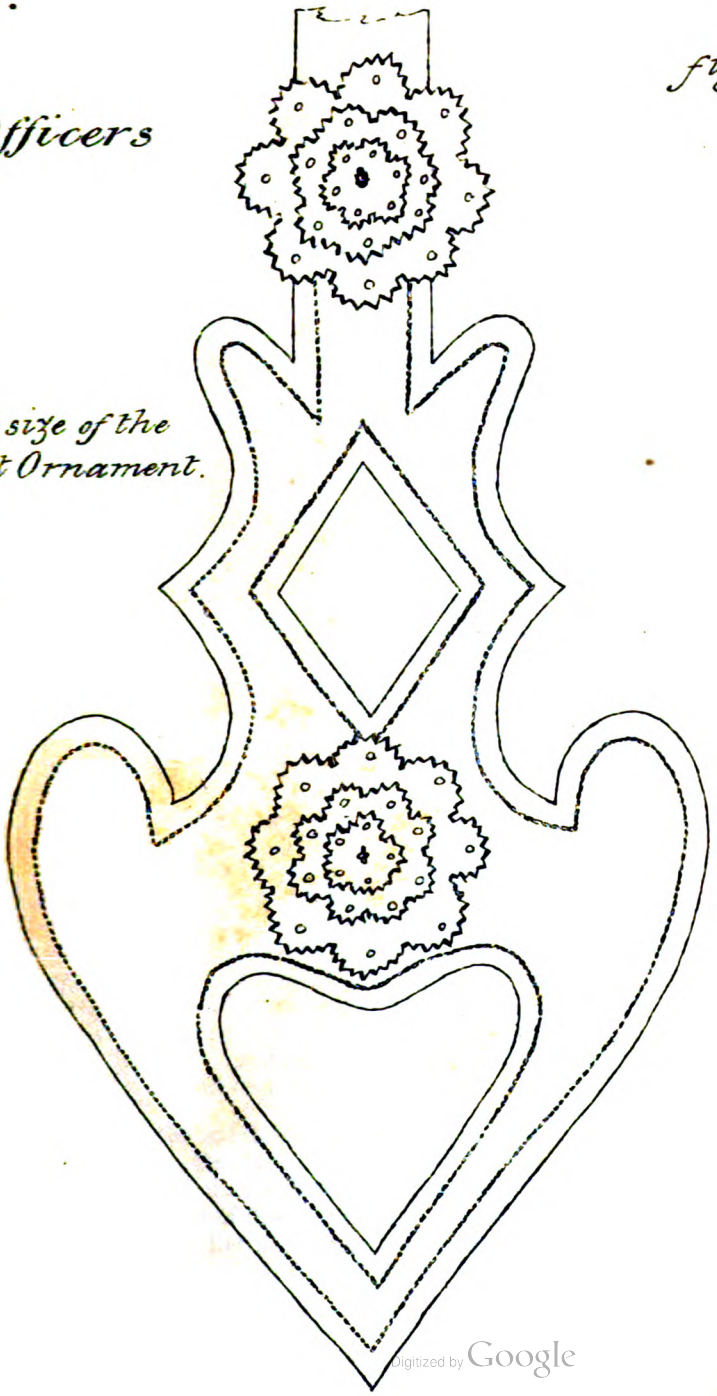
Digitized by Google

us.

e Officers

fig. 19.

Full size of the
reat Ornament.



Digitized by Google

Digitized by Google

IRON FIELD CARRIAGES, PROPOSED BY W. H. ROCHFORT, LATE LIEUT. COL. HORSE ARTILLERY IN THE SERVICE OF H. M. F. M. DONNA MARIA 2ND.

Under the impression that the columns of the *United Service Gazette*, are always open to the advocacy of the cause of truth, in all branches of art and science connected with the Military Service of Great Britain, and more especially when the just claims and merits of British Officers become placed in juxta position with those of foreigners, I feel no hesitation in soliciting, through the medium of your journal, public attention to the following statement of facts, in reference to certain transactions connected with recent experiments made in France, respecting the improvements in the field gun carriages for the French Service.

The substitution of iron for wood in the garrison and field gun carriages of the French Army, has been for the last 3 months a subject of much public discussion and experiment amongst the Senior Officers of Artillery Service in that country. Captain Thierry of the French Artillery, claims the honor of having invented these carriages ; he now proposes also the substitution in many cases, of iron for brass ordnance, but he admits that this improvement was suggested by, and taken from, the adoption of that metal by the English, so far back as the sieges of St. Sebastian and Badajoz.

Had he admitted the whole of this improvement to be English, it would have been more in keeping with that sincerity which is the usual characteristic of a frank soldier. In my statement, I shall hope satisfactorily to prove this to be the case. The substitution of iron for brass ordnance being admitted by Captain Thierry to have been taken from the English, I shall prove that the present suggestion emanated solely and entirely from myself. Thus will the assertion that "the whole improvement is of English origin" be established beyond all doubt.

So far back as the autumn of 1831, the plans and model of a Light Field Gun Carriage of my construction, were prepared by me for exhibition before Sir James Kempt, the then Master General of the Ordnance. I was however directed to General Miller at Woolwich, to whose inspection

Digitized by Google

(either singly or in Committee) every new invention is generally submitted. Unacquainted with that Officer, except in his professional vocation, I procured the introduction * of the late General Smith of the Royal Engineers, by which I made myself known to General Miller. That Officer declined the trouble of looking at either plan or model, declared the alteration could never answer, and nothing more passed between us on that subject.

General Miller was himself, as I afterwards discovered, a projector; and in the laudable desire of monopolizing the ideas of all innovation, appeared to deem his peculiar prerogative trenched upon, by the presumption of any one else who should dare to whisper or even think of improvement.

The new carriages thus dismissed, at least from discussion, General Miller politely invited me to the inspection of various parts of the Arsenal, and particularly called my attention to the economy he was practising for Government, by reboring a great number of otherwise useless iron guns, viz:— old twenty-fours, into two-and-thirties; old two-and-thirties, into two-and-forties &c.

I shall not forget the General's consternation, when I asked naturally, by what means he proposed to reinforce the trunnions and trunnions shoulders, as I could not imagine how the trunnions which are imperatively required to be of the diameter of the bore, could be encreased to the larger diameter to which, in all cases he bored; and I was equally at a loss to understand, how the metal bored away from within, and materially weakening the trunnion shoulders was to be made good. I have not been since at Woolwich, or indeed in England, but I am curious to hear the result, by trial, of the General's boring; and I shall be surprised to learn that the intended economy to Government has been effected.

Nothing however daunted by General Miller's reception, after a determination never to incur again that Officer's displeasure, or black looks, by any fresh disclosure of invention, I wrote to Marêchal Soult then Minister of War in France, tendering to his Excellency the plans and models which General Miller had so disdainfully rejected.

* Through the kindness of his son Capt. Leicester Smith, R. E.

Digitized by Google

The Duke of Dalmatia ordered a Commission of Artillery, presided by Lieut. General Neigre, to examine and report thereon, at which I was invited to attend.

The commission held its sittings in the month of March 1832, and from the flattering observations at that time addressed to me by the President Baron Neigre, I have reason to believe that the substitution of iron for wood in the field carriages, was favorably considered; and having replied during several hours to the various interrogatories of the Commission, I was informed that I should hear from the Minister of War shortly, if I was not, which was more probable requested to wait upon the Minister.

My suggestion embraced other improvements also, which however appeared to be considered by the Commission, as too expensive and intricate to be likely to be adopted. In returning the model to me, the Commission declared they had Marêchal Soult's order to retain the plan. I did not object, and the plan was accordingly replaced in the Minister's Portfolio.

If I wanted proof of the foregoing facts, it is to be found in various journals of the French metropolis in the month of April of that year, from one of which, the *National* dated the 18th of April, 1832, I extract the following article :—

" Nous Apprenons que monsieur W. H. Rochfort, Officier de l'artillerie Anglaise, vient de presenter au ministre de la guerre, le modéle d'une piéce d'artillerie de campagne qui offre de grands advantages sur le systeme actuel suivi en France. Le plus important de ces advantages, son pointeur servant pour a-juster, et qu'il pent a volonté et avec la plus grande aisance, diriger la bouche au cannon soit perpendiculairement comme cela se pratique anjour'd' hui,soit horizontalement. Les hommes de l'art comprendront bientôt l'immense amèlioration qui serait introduite dans l'artillerie par l'adoption d'un systéme qui rèsoudrait complétement ce problème, sans compromettre la celerite des manæuvres et la solidite de la piece, et sans rendre moins facile sa reparation lors qu'elle a recu quelque dommage. Un autre changement notable purposé par M. Rochfort est le remplacement de la fleche en bois par une double fleche de fer beaucoup plus légerè, et d'une construction bien plus êconomique que celle qui est en usage."

Digitized by Google

" L'on nous assure que les officiers superieurs d'artillerie aux-quels a été renvoyè le modele pour être examiné, l'ont jugé digne d'uneserieuse attention."

My immediate departure for Portugal was perhaps the cause of my hearing nothing more from the Minister at the time, and shortly after my return, I addressed Marèchal Soult on the subject, dated 5th March 1834, but without reply.

However upon representing the circumstances afterwards to Marèchal Gerard, who superseded Marèchal Soult in the War Ministry, I had the satisfaction towards the end of October of being assured by Colonel Tugnot de Lanoye, inspector du materiel de l'artillerie (to whom I submitted also the model formerly exhibited in 1832, before the French Commission) that Marèchal Gerard was satisfied, that my claim for priority of suggesting this improvement was just, moreover Col. Tugnot de Lanoye informed me, that my plan still remained in the archives of the War Ministry.

It is somewhat remarkable, that shortly after the despatch of my letter dated 5th March 1834, to Marèchal Soult, Captain Thierry's Pamphlet appeared, together with plans for the substitution of iron for wood in field gun carriages, and it is still more extraordinary, that this same Pamphlet bears on its title page the following recommendatory notice:—

Par ordre de M. le Marêchal Duc de Dalmatia, Ministre de la Guerre.

Comments would be superfluous, any person comparing the relative plans will at once declare the one to be as near as anything can be, a *fac simile* of the other. Captain Thierry has even fallen into my blunders!—blunders which I had fully explained to the French Commission would be remedied in the construction of a trial carriage, if the principle was approved. But these blunders remained in evidence in *my* plan left in Marêchal Soult's portfolio, and have been faithfully preserved in Captain Thierry's.

I will point them out now, as I did formerly to the French Commission. In both our plans, the traverse trail bolts are made of iron. They should have been made of brass with brass washers and iron screw nuts; this would essentially

Digitized by Google

relieve the vibration. Indeed all the connecting plates and bolts in both plans are made of iron, whereas in all cases where the working together of different metals is concerned, brass by the production chemically, of a more healthy action when in contact with iron (thereby tending to reduce friction) will diminish materially vibration, so destructive of all Artillery equipment.

Every connexion in an iron carriage, therefore, should be effected if possible without the contact of iron with iron. This would render the carriage not only more elastic but of longer duration.

Captain Thierry like myself, has also preserved in his plan the same length of trail that existed originally. One of the principal improvements I suggested to the French Commission, and still contend to be not only practicable, but of extreme importance, was the shortening the trail, whereby the weight of carriage or rather of draft would be considerably diminished. But I must request to be understood as to what I mean by diminishing weight.

Every gun carriage is required to be of a certain weight, or to have a certain resisting medium in order to avoid too great recoil. This can be acquired by weight only, and the lightest weight that will effect the necessary resistance to the impetus of discharge is, I presume, adopted. Trial alone can solve this problem, but assuming that this resisting medium or necessary weight has been found, by the experience of Artillerists to be, as at present in use, proportionate to various field calibres, I do not presume to meddle therewith, or to alter the absolute weight of carriage. But all weight of draft that can be spared especially in the Horse Artillery service, is an advantage incontestably worth obtaining. By shortening therefore the trail, the limber wheels are brought considerably nearer to the gun wheels, and the draft therefore materially diminished. The trail too can be shortened only by the substitution of iron for wood, as I shall presently shew.

I believe that many years ago, upon a trial of short wooden trails they were abandoned in consequence of the gun, from frequent firings or high charges, capsizing backwards, by reason of the large angle formed at the contact end of the trail with the ground, sometimes by not recoiling, the shock carried away the axletrees, and the grain of the wood not

Digitized by Google

permitting the trail to be curved without compromising the strength of the material, and rendering it liable to splinter, recourse was had again to the long double back straight trails, and these again were replaced by the single blocks now in use, long also and straight; long*, as I have described in order to obtain a less angle at the trail's contact point with the ground, and thus prevent capsizing backwards, or breaking down the axles; and straight, in order to preserve the strength of the wood. But the double craned iron trail of my suggestion, pronounced impracticable by Gen. Miller, and subsequently examined with approbation by Maréchal Soult's commission, not only removes these objections without compromise of any kind; but the centre of gravity of the carriage being thus much below the axis of motion, the carriage with a gun mounted would become infinitely less likely to upset, either upon unlevel ground, or roads such as too often occur in France, Spain, and Portugal, and in almost every march made by our armies in Hindostan.

In the rapid movements of Horse Artillery, the equilibriums in wheeling would be more securely preserved, and for rocket carriages the advantages would be innumerable.

The duration of an iron crane carriage over a wooden one, must be considerable, the difference of cost if any, trifling; hence its great economy.

This therefore would combine a saving of material, work, and labour, in the carriage department, and a most prodigious saving of labour and draft to Artillery horses, which thus would not only be kept fresh for rapid and repeated movements in the field, but rendered capable of surmounting the most arduous difficulties and accomplishing the most signal enterprizes.

I trust that I have satisfactorily established my claim as the projector of this improvement, and that I have clearly demonstrated the advantages therefrom arising.

If the perusal of this article or other circumstances should decide His Britannic Majesty's Government to make trial of an iron crane carriage upon this system, I shall be happy to tender my feeble services.

* I once heard an Artillery Officer assign as a reason for the trail being obliged to be long, that it was so required for the convenience of limbering up, and unlimbering hastily in action, but he was a very young Artillery Officer.

Digitized by Google

MEMORANDUM BY CAPTAIN J. SINCLAIR, BOMBAY ARTILLERY, ON IRON CARRIAGES FOR LIGHT FIELD ORDNANCE, APRIL 1835.

1.—The accompanying sketch fig. 20 exhibits the principle, on which it is proposed to employ Iron in the construction of Ordnance Carriages.

2.—The benefits to be expected from the use of iron in lieu of wood are;

1st. Greater durability and elegance of appearance, combined with facility and economy of construction;

2d. Less liability to splinter if struck by shot in action;

3d. Greater strength without increase of weight.

4th. Owing also to the gun lying so much lower on an iron, than on a wooden carriage, the combined machine will move with greater security on uneven ground.

3.—The use of iron, on the principle shewn in the accompanying sketch, will admit of one carriage being used with two pieces of ordnance; thus, by shifting the trunnion beds *a. a*, (cast iron) from one side to the other, and advancing the transom of the elevating screw, a carriage prepared, as represented A, for a 6 pounder Field Piece, may be adapted to a 12 pounder howitzer B. In like manner, one description of carriage may be constructed for use with two guns, of nearly the same strength; such changes, altho' occasionally expedient, would only of course be made when circumstances rendered it absolutely necessary.

4.—A slight difficulty presents itself to such an arrangement, from the circumstance of the trunnions of guns and howitzers being cast of different dimensions; this is easily obviated at present, by furnishing the smaller trunnions, used with any particular carriage, with compensating rings or sockets, but if the principle of thus having one carriage adapted for use with two or more pieces of ordnance, be approved of, I can see no objection to having the trunnions of field guns and howitzers hereafter cast of similar thickness.

5.—The wheel, as exhibited in the accompanying sketch, is constructed around a cast iron nave C, formed to receive a double row of hollow cylindrical spokes, each felloe is form-

Digitized by Google

ed to cover any convenient number of spokes, and is pierced to receive the ends thereof, to the depth of an inch *d*, and entirely through, to receive the pin, which passing through the felloe, is driven into a plug of hard wood, with which the cavity of the spoke is filled, the tire is now to be put on in the manner usual with wooden wheels, and is held by the same rivets which bind together the felloes, where, for greater strength, they are spliced *e. e.*; the number of spokes and their particular position will be regulated according to the length of the nave, and breadth of the tire &c. thus, for a heavy ordnance wheel fourteen pair will be required, the cylinders composing each pair, being placed farther apart than in the wheel for light ordnance, while for the seven foot wheel of a sling cart, it will be requisite that the spokes run in sets of threes, of which fourteen will be necessary.

6.—Wheels thus constructed, will be as easily repaired as those made of wood, (the spokes, being formed of unserviceable musketry barrels, may be said to be always at hand,) and thus, is effectually obviated, one great objection hitherto made, to the use of iron in the construction of ordnance wheels.

7—.I beg leave to disclaim all intention of arrogating to myself the merit, if there be any, of proposing the use of iron, instead of wood, in the construction of gun carriages, the proposal has been made elsewhere, and in some degree long ago acted on; that iron has not been generally used, I attribute as much to the faulty construction heretofore proposed for iron carriages, as to the high price of the metal in former years; both objections, I trust may now be considered as obviated, the low price of Iron at present, rendering it doubtful whether iron carriages may not cost less than those of wood. The idea of adapting one carriage for use with two or more pieces of ordnance I submit as my own, altho' Ihave lately heard that a wooden carriage (on a construction totally different from that now brought forward,) has been proposed in France, with this object in view.

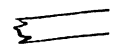
8.—Since first submitting to superior authority, a proposal to introduce into the Bombay Artillery the use of iron Field Gun Carriages, my attention has been arrested by a succinct account of a similar project having, under the orders of Field Marshal Soult,been successfully attempted in France, with the addition of iron limbers and ammunition

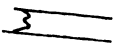
Digitized by Google

a.... S
b..... -
c
o
c..... I.
d..... I
e.e.... S.
f..... -
I.
gg.... I.

C







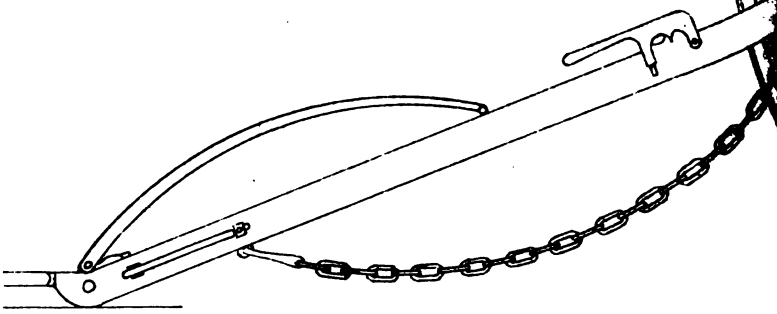
Digitized by Google

Miscell

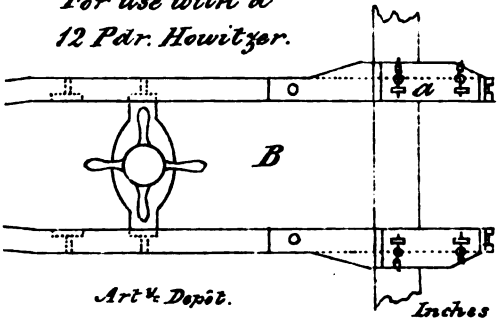
Sketch of an
by Capt ⁿ J. S

References.

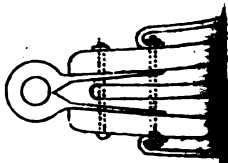
Shifting trunnion beds.
A block of wood inserted at the junction of the Iron Cheeks, to afford a broader base to the Trail than would otherwise be gained without great increase of weight.
Iron nave.
Ends of spokes let into felloe.
plices, or joinings of felloes.
A pin stopping up the hole, thro' which oil is poured into the reservoir in the Nave.
Holes pierced in the Nave box to admit the oil from the reservoir.



For use with a
12 Pdr. Howitzer.



Art ⁴ Depot.

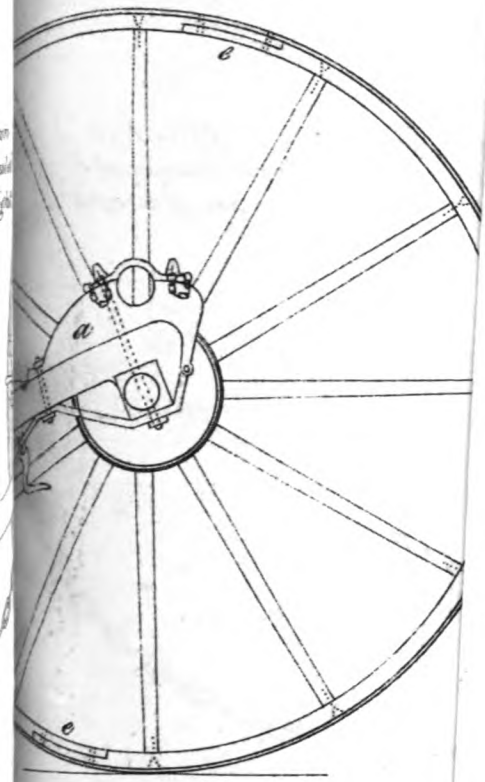


Inches 12 9 6 3 0

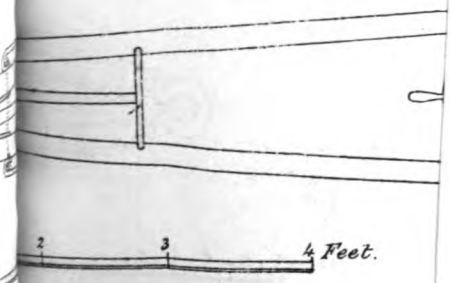
Digitized by Google

eous.

Carriage,
r Bombay Art^{y}

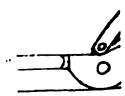


For
6 Pdr

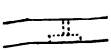


Digitized by Google

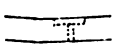
'hifti
A block
heeks,
therwi
ron ra
Ends of
plices, &
A pin s
oured
Holes p
from t



For
12 f



C



Digitized by Google

boxes, the plan on which the carriage is constructed, is not detailed, enough however is said to prove the accuracy of my original opinion as to the advantages likely to be derived from the use of iron.

9.—The adoption of metal in the construction of ammunition boxes, seems to be imperatively called for in Europe, to secure the ammunition against the destructive effects of the rifle detonating shell of an active enemy.

The necessity for the adoption of metal boxes in India is not perhaps so evident, but, as sooner or later they must be introduced, it is perhaps better to commence at once ; at all events, the use of iron in poles, shafts, splinter bars, &c. will probably be found economical, and on this account ought at once, I submit, to be introduced.

THE PROPER METHOD OF DIRECTING ARTILLERY AGAINST BOATS ADVANCING TO THE ASSAULT.

By a Correspondent of the United Service Gazette, 9th January 1841.

In defending a breach, the first thing to be observed, is the selection of a proper position for the guns. If field batteries are to be employed, or if field works are to be thrown up for the occasion, I should place them as near as possible on a level with the water, and at about 100 yards from where the boats are likely to take ground, so that the cone of fire of each round of grape, or case, might attain a good opening before it got among the enemy in confusion, as they must be, while stepping out of their boats and forming on the beach. But if the nature of the coast were such, that ships could get sufficiently in shore to protect the landing, I should place my guns, if possible, at about 50 feet above the level of the water, where they would be safe from all random or ricochêt shot, by being above the path described in the air by those shots which might bound from the water. These batteries should be planted well on each flank of the position, so as to maintain a cross fire.

Now in firing at objects not more than four feet above the surface of the water, such as boats with their crews, boats too,

Digitized by Google

not in a broad deep column, but in line abreast, the practice which is most likely to be attended with success, must unquestionably be that which would cause the shot throughout the whole of their course to the extreme range of their guns, to be nearest a *fleur d'eau*, that is, parallel to the water. Well then, whether in firing from a ship or from guns on shore, against objects perpetually changing their distance, such as boats, I would lay all the guns horizontally, with the coins nailed to the beds, and the elevating screws fixed so as to keep the guns in this position, thus rendering the service of the gunners merely mechanical, and then await the enemy. Shot fired with the service charge from guns, so laid, would make their first graze at from two to four hundred yards from the battery, according to the nature of the ordnance employed, and then ricochêt on the water to the distance of, from one to two thousand yards, as the water might be more or less favorable.—And be it observed, that if the sea be sufficiently smooth to admit of a debarkation of troops, or an attack of boats on a vessel, it will be sufficiently smooth to enable shot to ricochêt, or, in more familiar language, to make "ducks and drakes." The guns should then open their fire as soon as a try shot indicates that the boats have arrived within the extreme range. Now, shot fired as we have described will, in the last three or four hundred yards of their course, make such frequent and short bounds, with curves of so little altitude above the surface of the water, that the chances of hitting any low object will be multiplied. When I should observe, that the boats had advanced beyond the spot where these short bounds were made, I would double shot the guns, thereby reducing their extreme range, and consequently keeping the boats still exposed to the repeated low terminal bounds of the shot. As the boats came still nearer, I would, for the same reason, load with reduced charges, in cartridges previously prepared, still double shotting my guns, until they got within grape range, when I would return to the service charge, putting a round shot into the guns to each round of grape, and depressing the guns, if on an elevated spot, so that the enemy might find themselves in a storm of iron hail while stepping from their boats on to the beach.

Picture to yourself from six to forty or fifty boats pulling eighteen hundred yards, that is to say, a mile, exposed as they must be for a quarter of an hour or twenty minutes to this razant fire, if even of only half a dozen guns so directed,

Digitized by Google

and discharging from one to two rounds per minute, then imagine the boats diverging from their course in all directions, to avoid the projectiles which they see dotting their deadly path for hundreds of yards in their front ; and then skimming along like a shoal of flying fish, and taking the whole line of boats *en echarpe*, that is obliquely, if the batteries cross their fire, as they should do. Can you expect even the stoutest hearts to go through this ordeal of fire ?

For my own part, I have always been of opinion, when the ground will admit of it, that Field Artillery should be served so that the shot may graze several times before they get to the troops, and then make ducks and drakes among them ; reducing the charges, so as to produce this effect at short ranges, thus keeping the shot's entire path as near as possible, a *fleur de terre*. For if a shot enter at one flank of a Regiment, and strike down a file or two, it is probably not seen, or unheeded, by the men on the other flank ; but if this messenger of death had been witnessed by the whole battalion, bounding like a cricket ball for some hundred yards in its front, probably with erratic course, each individual would have been anxiously waiting its progress, in dread expectation of its entering where he was standing, thus "dying a thousand deaths in fearing one."

The whole battalion is thus kept on the *qui vive* ; and we may imagine the consequences of multiplying shot, so that all the plain in front should be incessantly ploughed up by the instruments of destruction, which are then made distinctly visible to every eye. Shot so discharged, be it observed, not only increase the chance of positive destruction, but produce effects on the imagination which may have as much or more to do in deciding the fate of the day, as absolute slaughter itself.

If this theory be correct in practice on shore (and I think those who have ever witnessed shot coming towards them with a ricochêt, will admit that it is so), it is even more applicable to the fire against boats, where the men are exposed to a double chance of death. And gunners must remember that concentrated destruction produces more effect than destruction in detail ; that it is far more important to sink one boat, especially in the early part of the onset, than to destroy, in various parts of the line, treble the number of men so lost ; because the one sinking boat calls two or three other boats to its assistance, thereby breaking and putting

Digitized by Google

the line in confusion, and the boats thus clustered present a better mark for the gunners. Not so when a boat is sinking under the immediate fire of grape, for then it is *sauve qui peut*, and every boat pulls with all its might to get out of fire and put an end to the affair by boarding the vessel sword in hand, or making good their landing, and, at the point of the bayonet, driving the cannoniers from their guns.

Auxiliary Obstructions.

When the nature of the beach is such as to determine the exact point where the landing must be made, such obstructions may be put in the way as shall cause a detention of the boats, where they will be exposed to the slaughtering fire of grape, and to the point blank range of musketry.

For this purpose fishermen's nets, spars, and double or treble ropes floated with billets of wood, should be moored with kedges or heavy weights close to the shore, but in that depth of water where the men cannot jump out of the boats to wade ashore. Within this barrier, felled trees with the small twigs cut off and the branches sharpened at the points, should be dragged into the water and formed into a continuous sunken abattis. Carts and waggons interlaced with ropes, may be similarly employed. Ploughs, cart wheels, barrows, hurdles, three legged trestles, made at the moment by lashing short lengths of wood together, all sunk with stones, and pickets driven into the sand and interlaced with cords forming zig-zags under water, should be placed where the men are likely to jump from their boats, that they may be tripped up as they wade along.

These impediments should be placed if possible over night, so that they may not be perceived by the assailants until they are entangled in them. But if they cannot be placed before hand, or if the particular point of landing cannot be ascertained until the boats shove off, the nets and floated ropes of which I have spoken should be held in readiness, and placed as soon as the exact point of debarkation is evident. Vessels which are threatened with being cut out, should circumscribe themselves with these floating barriers, placed within complete command of musketry. Rockets, if fired so as to skim the water, would prove as destructive, and even more terrific and appalling than shot.

Digitized by Google

With a few such impediments, if the assailants be in any reasonable proportion to their enemy, and they allow the fellows to step from their boats, they will richly deserve what they will assuredly get. Indeed, unless opposed by an overwhelming force, if the batteries be vigorously served and directed so as to make ducks and drakes among the boats, if the Artillery be well supported by musketry, and if a few resolute horsemen will scour the beach, acting on both flanks ; or if the Infantry, in the absence of Cavalry, will follow the example of the ancient Britons, who opposed Cesar's legions, and meet the foe at the point of the bayonet as they are in confusion stepping from their boats, I cannot conceive how a single hostile foot should ever be allowed to leave a print on the sand a dozen yards beyond the water's edge.

I would here beg leave to recommend ; that experiments to determine the best method of managing cannon when firing against boats, should be carried on from on board the Excellent, and by the Artillery at Deal or other convenient Stations. Sugar hogsheads, which are of but little value, might be floated on rafts to represent boats. A point like this, really by no means trifling, should be ascertained and promulgated, and not left to be hit upon by chance at the time of need, when men, from want of some rules, in which they have confidence, lose all self-possession.

EFFECT OF SPHERICAL CASE SHOT.

Extract from a Narrative of seven week's captivity in Saint Sebastian, from the first storm to the capture of the Castle in 1813.—*By Lieut. Col.* H. Jones, *Royal Engineers.*

"During this period every body sought shelter where best he could among the rocks ; still no nook or corner appeared to be a protection from the Shrapnel shells. A Serjeant of the Royals, standing at the foot of my bedstead, was killed by a ball from a Shrapnel shell, and fell dead upon me. An Italian soldier, who had been appointed to attend upon the wounded prisoners, whilst endeavouring to close the hospital door, to prepare some bouillon for our dinner, was, with his marmite, blown into the air : and so ended, for the day, all our hopes of obtaining a little nourishment Life and bustle had disappeared : scarcely an individual was to be seen moving about."

Digitized by Google

" This state of affairs continued until the batteries in the trenches slackened their fire. Nothing was done, everybody sought shelter from the tremendous fire of shells which was poured into the castle, and to escape from the terrific effects and havoc caused by their explosion. The whole interior was ploughed up; and had this stream of fire been continued a few hours longer, the garrison would have obliged their Governor to surrender."

" The shriek of the bullets from a shrapnel shell, is very different from the whistle of a musket-ball ; and oft repeated were the exclamations; *Ah ! ces sacre boulets creux !* It may not be unworthy of remark, that the bullets discharged from a Shrapnel shell assume the form of a polygonal prism."

" A French Officer showed me one that had just been extracted from a wounded man : he anxiously inquired whether they were of that form when put into the shell. I afterwards observed the same in many others, which, at my request, were handed to me by the operating surgeons."

"The excellence of the British Artillery is well known, nothing could surpass the precision with which the shells were thrown, and the accuracy with which the fuzes were cut It is only those who have had the opportunity of witnessing their fire, and comparing it with that of the French, that can speak of its superiority. During the siege, we little heeded the lazy French shells thrown into the batteries or trenches. From the length of the Fuzes, sufficient time was almost always allowed, before bursting, to put ourselves under cover, and, when they did burst, the splinters flew lazily around. On the contrary, when the sound of an English shell was heard in the Castle, or when the man stationed in the donjon cried " *Garde la bombe,*" every body was on the alert. The velocity of its flight far exceeded that of the French, touching the ground and bursting were almost simultaneous ; and then the havoc and destruction caused by the splinters were tremendous."

" None but those who have been exposed to the effects of Shrapnel shells, can fully appreciate the advantages of possessing such a terrific and destructive missile. It appeared to be of little avail where a man placed himself for protection, No place was secure from them, and many a Soldier was wounded without having been aware that any shell had exploded in his neighbourhood."

Digitized by Google

METALLIC CONDUCTORS FOR POWDER MAGAZINES.

Extract from the Minutes of Consultation, No. 1571, 17*th April* 1841.

" Read the following letter from the Secretary to the Government of India."

" Here enter, 24th March 1841, No. 490."

" *Ordered*, that the foregoing despatch be communicated to the Military Board, in reference to an Extract from the Minutes of Consultation, No. 4196, dated the 17th November 1840."

" Ordered also that further proceedings respecting lightning conductors be postponed until the decision of the Honorable the Court of Directors be received upon the proposal of the Government of India"

" This Minute will be brought to the notice of the Honorable Court."

(Signed) S. W. STEEL, Lieut. Col.

Secretary to Government.

Extract of a letter No. 490, *from the Secretary to the Government of India, Military Department, dated Fort William,* 24*th March* 1841, *to the Secretary to Government Fort Saint George.*

" In reply to your despatch No. 709 dated 19th Ultimo, I am directed to acquaint you, for the information of the Government of Fort Saint George, that professor O'Shaughnessy's report, of which a copy was transmitted to you with my despatch No. 279, dated 21st October 1840, has been forwarded to the Honorable the Court of Directors, with a suggestion, that the opinion of professor Faraday might be taken regarding it; and with a request, that, in the event of its being deemed desirable, to have the several Powder Magazines protected in the manner pointed out by professor O'Shaughnessy, the Honorable Court would consider the

Digitized by Google

propriety of having the necessary rods prepared in England, and sent out for use; a procedure likely to diminish the cost of the apparatus, and to conduce to the more speedy preparation of it."

2. "A communication from the Military Board, with a further explanatory report from professor O'Shaughnessy, was at the same time transmitted for the consideration of the Honorable Court; and copies of that communication and report are herewith forwarded for the information of the Government of Fort Saint George. It has not been deemed expedient to act upon the suggestion submitted by the Military Board, pending the receipt of instructions on the subject at large, from the Honorable Court."

3d. "The report of the Committee appointed by the Lords of the Admiralty alluded to in your despatch, has not yet been received."

Extract of a letter No. 5345, from the Military Board Fort William, to the Right Honorable GEORGE, *Earl* AUCKLAND, G. C. B., *Governor General of India in Council, dated 15th January* 1841.

"With reference to Lieut Colonel Stuart's letter No. 390, dated the 21st October, we have the honor to submit in original, the papers noted in the margin, a letter dated 29th December, from Dr. O'Shaughnessy with enclosures, in which professor O'Shaughnessy explains the nature and dimensions of the rods which he recommends as lightning conductors."

2d. "We beg to recommend that the report be submitted for the consideration of the Court of Directors; and in the mean time, we would suggest that the professor be desired to place himself in communication with Captain Fitzgerald and Lieut. Fagan, and to select some one Magazine at the Presidency, or at Dum Dum, which he should, as an experiment, be requested to protect entirely according to his own views of what such protection ought to be."

3 "This measure will, we conceive, form a correct guide to a knowledge of the cost of the general introduction of his scheme, than any that we at present possess."

Digitized by Google

Extract of a letter No. 450, *from Lieut. Colonel* J. STUART, *Secretary to the Government of India, Military Department, to the Military Board Fort William, dated* 17*th February* 1841.

"I am directed to acknowledge your letter No. 5345, dated 15th ultimo, submitting a despatch from professor O'Shaughnessy, explanatory of the nature and dimensions of the rods, which he recommends for lightning conductors; and suggesting that the professor may be desired to select any one Magazine at the Presidency or at Dum Dum, to be protected against lightning, according to his views as an experiment."

2. "The Right Honorable the Governor General of India in Council, directs me in reply to inform you, that professor O'Shaughnessy's report will be transmitted for the consideration of the Honorable the Court of Directors; but His Lordship in Council, does not deem it expedient to authorize the experiment suggested by your Board, pending the receipt of instructions from the Honorable Court on the subject."

3. "The original documents which accompanied your letter are returned herewith, and you are requested to furnish for record here, a copy of professor O'Shaughnessy's despatch, also three copies of the sketches appended thereto, two of the latter being intended for the Court of Directors."

Extract of a letter No. 6688, *from the Military Board, Fort William, to the Right Honorable* GEORGE, *Earl* AUCKLAND, G. C. B., *Governor General of India in Council, dated* 12*th March* 1841.

"In conformity with the orders conveyed in the 3d. para of Lieut. Colonel Stuart's letter No. 450, under date the 17th ultimo, we have the honor to forward herewith, a copy of professor O'Shaughnessy's report on lightning conductors, together with three copies of the sketches and figured statements appended thereto."

Digitized by Google

Letter from W. B. O'SHAUGHNESSY, *Assistant Surgeon, to* MAJOR DEBUDE, *Secretary to the Military Board, Fort William, dated Calcutta, 30th December* 1840.

"I have the honor to return herewith the plans of Magazines, and the descriptions of adjacent objects, received with your letter of the—instant; I have drawn up memoranda upon each, in which I state fully, the number and position of the conductors which I recommend."

"Attentive consideration of the specifications you have sent me, has led me to believe, that a much cheaper and more efficient system of conductors is applicable in many cases, than that which I proposed in my previous papers, before I had received from you the data your last despatch supplies."

"I would in the first place remind your Board, that every fact in the history of lightning, shews it to be *surface* of conductor not *mass*, which is required for the safe conveyance of the electric discharge; secondly, that copper is unequivocally shewn, and admitted by all authorities, to be about 7 times superior to iron in conducting power; thirdly, the cost of inch copper bars being at least (2) two Rupees the running foot, opposes an insuperable obstacle to their being employed in the numbers I consider absolutely requisite for efficient protection. Regarding this point I refer the Board to the details of a very remarkable experiment described in the appendix, and the inferences I draw from its consideration."

"For all these reasons, I propose in lieu of rod iron or copper, to erect conductors of sheet copper attached to masonry pillars, 3 feet square at the base tapering to 1½ feet at 30 or 35 feet high, and terminating in a light spar of 10 to 15 feet—along this support, I would fix a 3 inch copper strap, cut from the sheet. This strap should be led into the ground away from the building, as far, and as deeply as economy would permit, but never less than 10 feet deep."

"The expence of such a pillar conductor would amount to

Masonry.....150 Rupees.

Digitized by Google

1 Maund of copper at 35 Rupees will give 320 feet, of three inch straps; say the conductors average 64 feet in length, this would give the cost of each only 7 Rupees."

"A system similar in most respects, is now adopted in the Royal Navy in preference to the old rod conductors. There can be no doubt of the superior efficacy and economy of the straps, altho' I agree with Sturgeon and others, in considering Mr. Harris (their proposer) to be reckless of very possible consequences, to a most blameable degree, with reference to the position and direction he has placed these conductors in; namely, running right thro' the vessel, and in one case passing close to the after magazines. I would again urge the necessity of erecting a 6 to 10 feet wall wherever practicable at 10 feet distance from each magazine, and along which a copper strap should be laid down as described in the memoranda No. 7."

DESCRIPTION *of Experiments by Asst. Surgeon* W. B. O'SHAUGHNESSY, M. D. *shewing that an electric discharge (lightning) may leave a good and large and well constructed Conductor and pass to other conducting objects in the vicinity.—29th December* 1840.

In the sketch fig. 21 *a* represents a large leyden jar, *b* a ball in connection with the inner coating, *c* a model lightning conductor of copper rod, $\frac{1}{4}$ of an inch in diameter terminating in a point, and *d* the discharging rod by which the electric accumulation can be exploded from *b* to *c*.

On discharging the jar, the explosion passed as might have been anticipated without fusing the bar, and in a single discharge.

A second copper rod was now added, bent as shewn in the sketch fig. 22 one end (pointed) being brought to within a $\frac{1}{4}$ of an inch of the conductor *c*, the other end in metallic contact with the outer coating.

At every discharge thro' the principal conductor *c*, a bright spark passed at +, this could not have been what is called the "residual" charge, for it was simultaneous with the main explosion.

Digitized by Google

In the next experiment, it was found that cutting *d* at + +, and placing detonating powder in the section, it exploded simultaneously with the main discharge.

Instead of a point, the rod *d* may terminate in a ball, and the same phenomena ensue.

Increasing the size, or charge of the jar *a*, caused the spark at + to increase proportionally, and the striking distance to increase.

I regard this as direct experimental proof, that electric discharges will subdivide themselves, that is, that a proportion of the discharge will desert a conductor (in itself sufficient to carry off a still greater quantity) and will strike to other conducting bodies in the vicinity. Let us not dispute about the name to be given to the discharge, call it "lateral," "residual," "direct," or "return," it matters not. The fact of importance is, that a powerful spark does pass between the conductor and adjacent conducting bodies. I ask emphatically, if with a quart jar this spark takes place, thro' ½ of an inch, it is exaggerating probabilities to apprehend, that as a flash of lightning passes thro' a conductor placed close to a magazine, the analogous spark may penetrate the wall in obedience to the influence of the copper powder barrels within.

It seems to me, that these facts with others previously adduced, leave us no choice or alternative. If we erect lightning conductors at all, we must erect them in numbers greater than those usually provided, and we must place them at a certain distance from the magazine we wish to protect.

No. 1—Royal Magazine, Fort William.

Length.	Breadth.	Height.
88½ feet	45 feet	30½ feet.

On the plan there are 5 projections marked at each side, which I presume to be solid buttresses, each 8½ feet deep. If I am correct in this idea, I would attach a conductor 45 feet high to the corners, which I have marked *a. b. c. d.*, and at one foot from the buttress;—a strip of copper or lead one inch broad should connect all

Digitized by Google

Miscellaneous.

Doctor O'Shaughnessy on Lightning Conductors.

fig. 21.

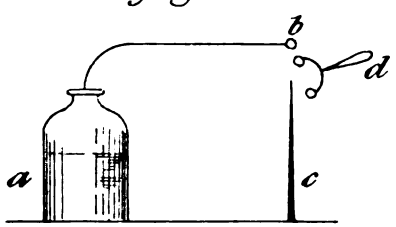
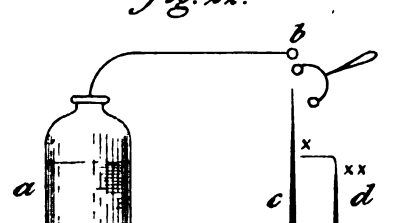


fig. 22.



Art^y. Depit.

Digitized by Google

Digitized by Google

the four conductors, the higher this connecting band is placed the better, and for convenience of support, it might run along the top of the projections.

I would also place a conductor 60 feet high, at each end of the Royal Barracks, which I have marked *e. f.* in the plan.

Assuming the protecting power to extend over an area, of a radius of twice the length of the conductor above the highest point of the building, the conductor here proposed should place the building in security from direct discharge.

No. 2—Duke of York's Magazine, Fort William.

I also propose four conductors similarly placed as marked in the plan; height and mode of attachment the same.

I do not understand what the red square I have marked * refers to.

The heights of the bastions should have been stated in the plan.

No. 3—Queen's Magazine, Fort William.

Length.	Breadth.	Height.
80 feet	44 feet	31 feet

apparent depth of buttresses 7½ feet.

The furthest point to be protected from the extremity of the corner buttresses is 40 feet, conductors at one foot distance from the buttresses must therefore be 21 feet higher than the building, total 52 feet high.

The connecting straps should be applied as before. The number of conductors recommended is 4, placed as marked *a. b. c. d.*

No. 4—King's Magazine, Fort William.

Length.	Breadth.	Height.
80 feet	44 feet	30½ feet

apparent depth of buttresses 5 feet.

N. B. breadth does not agree with the scale, it should by this be 65 feet and the length 80. I think four of the buttresses here, should be deepened or run out to 8 or 10 feet, and a conductor applied to each. As the farthest point to be protected is 55 feet, the conductor should be 22½ feet higher than the building, or 53 feet from the ground (see the marks *a. b. c. d.*)

Digitized by Google

No. 5—Grand Magazine, Fort William.

Length.	Breadth.	Height.
95⅓ feet	39 feet	24 feet 3 inches

Buttresses 5 feet deep.

Deepen 4 of these to 10 feet each, and attach a conductor to each. The distance being 90 feet across from *a* to *b*, the radius to be protected by each is 45 feet, the conductors should be 22½ above the building, or 46 feet, 9 inches from the ground.

There being a large building which I have marked thus * * 40 feet high, and distant from the interior of the Magazine 50 feet, (nearest spot) from angles of building 60 feet. I would propose a conductor to be placed at the angles marked ⊖, this conductor to be 50 feet from the ground. These conductors may be strips of sheet copper attached directly to the building and soldered by brass solder to a copper or iron rod 10 feet high above the roof.

If the buttresses in these cases be only foundation ones, I should recommend masonry pillars to be erected on the spots I have marked, and of such dimensions as seem necessary for the support of the conductor, which may be agreed on, I should consider 3 feet square tapering to 18 inches, and built on the foundation butteresses as quite sufficient.

No. 6—The Cheekwah Magazine.

The nearest building is but 10 feet high, and 107 feet distant.

Length.	Breadth.	Height.
31 feet	18 feet	16 feet

A conductor at each end *a. b.* 6 feet away, will make the distance 46 feet ($\frac{1}{2}$=23) so that 32 feet high above the ground, should be sufficient.

The adjacent buildings may be neglected here.

No. 7—Ishapore Magazine.

The buildings are not sufficiently near to need attention.

Digitized by Google

Length.	Breadth.	Height.
70 feet	46½ feet	18½ feet

A straight line thro' the middle carried 10 feet from each end gives 90 feet, this would require two conductors 22½ feet higher than the roof or 41 feet above the ground ; I think it would be well to erect also two smaller conductors, say 25 feet high and 10 feet distance from the side walls at *c. d.*

For the convenience of lateral connexion it would probably be expedient to erect the conductors at the corners. The bearings of the magazines are not given, but if practicable, it would be desirable to erect one of the principal conductors towards the north west.

The plans do not shew whether the magazines are separate or together, nor do they specify the interval between them. If merely separated by a moderate interval, I would place two conductors for each, at the ends *a. b.* and one lateral conductor of equal height at *c.* and *d.* all the angles and all the buttresses should be metallically connected. If isolated, there should be 3 conductors for each.

No. 12—Dum Dum Magazine.

Nearest buildings too far off to need notice.

Length.	Breadth.	Height.
34 feet	15 feet	17 feet

Erect 2 conductors 10 feet from each end, 13½ feet above the highest point of magazine, or 30½ above the ground. Place a third conductor smaller if desired, at the north west side, and connect all by copper straps.

No. 13—Duckinsore Magazine.

Length.	Breadth.	Height.
145 feet	57 feet	19 feet

Erect six conductors 10 feet from building, and in the sites marked * and connect all metallically. The nearest object need not be noticed, I think a wall 10 feet high might be erected with great advantage at 10 feet distance all round this magazine, and if this be done a few chevaux defrize spikes might be disposed all above the wall.

Digitized by Google

No. 14—Patta Magazine.

Of the same dimensions as the last, and calls for precisely the same remarks.

No. 15—Moyapore Magazine.

Length.	Breadth.	Height.
67 feet	63⅓ feet	18 feet

Erect four, 40 feet conductors, and unite them metallically. I think a ten feet wall would be very useful here.

No. 16—Berhampore Magazine.

Two pillar conductors 35 feet high ; and one to the armoury, on the building itself.

No. 17—Gowahatti Magazine.

No adjacent buildings to be noticed.

Length.	Breadth.	Height.
56 feet	18⅓ feet	17 feet

Erect two pillar conductors 20 feet higher than the building (37 feet) one at each end, 10 feet distance, and one 30 feet conductor at the side.

No. 18—Dinapore Magazine.

No building to be noticed.

Erect four conductors as marked.

No. 19—Dinapore Magazine.

Surrounded by, and in contact with buildings.

Length.	Breadth.	Height.
36 feet	23 feet	18 feet. 8 ins.

The adjacent buildings, are from 14 to 21 feet high.

Erect 4 conductors, 35 feet each, one at each cardinal point, or as near it as possible, and attached to the adjacent buildings ; thus rectedthe cost will be very trifling.

Digitized by Google

No. 20—Howrah Magazines.

Length.	Breadth.	Height.
49 feet	29 feet	25½ feet

There is a boundary wall 80 feet from the magazines, three 40 feet conductors recommended for each magazine.

The adjacent buildings need no notice.

No. 21—Neemuch Magazines.

Length.	Breadth.	Height.
31½ feet	11½ feet	10 feet

Nearest building does not require notice.

Erect two 25 feet conductors, one at each end as marked.

No. 22.

Length.	Breadth.	Height.
25 feet	17 feet	10 feet

Nearest building (Regimental school room) 90 feet distant, 12 feet high.

Erect two 25 feet conductors as marked, and one also 25 feet at the next point of the Regimental school.

No. 23.

Length.	Breadth.	Height.
35 feet	17 feet	10 feet

Rear guard just 67 feet, and out house of bungalow, 66 feet distant.

Erect two 25 feet conductors for the magazine, and one at each of the buildings above marked.

No. 24.

Length.	Breadth.	Height.
35 feet	17 feet	10 feet

Rear Guard 67 feet off.

Erect two 25 feet conductors at magazine, and one at the rear guard.

Digitized by Google

No. 25.

Length.	Breadth.	Height.
35 feet	17 feet	10 feet

Rear Guard 67 feet off.

Erect conductors as above.

No. 26.

Length.	Breadth.	Height.
41 feet	19 feet	12 feet

Rear Guard 67 feet, erect as above.

No. 27.

Length.	Breadth.	Height.
34 feet	11 feet	11 feet

Nearest building 63 feet distance, 10 feet high. Erect two 25 feet conductors at magazine, and one to the bell of arms.

No. 28.

Length.	Breadth.	Height.
41 feet	18 feet	14 feet

No adjacent building.

Erect 3 conductors each 25 feet as marked.

No. 29.

Length.	Breadth.	Height.
34 feet	18 feet	14 feet

No adjacent buildings.

Erect three pillar conductors each 20 feet.

No. 30—Chunar Magazine.

With a compound wall ten feet high, and 10 feet apart at all sides, and adjacent buildings none higher than 15 feet.

Erect four conductors as marked at the compound wall, and each 40 feet high.

Digitized by Google

Allahabad Magazines.

No. 31—Grand Magazine.

Length	Breadth.	Height.
90 feet	43 feet	20 feet

The Main Guard is 109 feet distant, and 30 feet high.

Erect four 40 feet conductors as marked, and one to the Main Guard also 40 feet.

No. 32—or Allahabad No. 2.

Building an octagon of 64 feet diameter, height 24 feet.

Erect 4 pillar conductors, one at each alternate angle, and 10 feet from the wall, each conductor to be 40 feet high from the ground.

No. 33—or Allahabad No. 3.

Length.	Breadth.	Height.
53 feet	37 feet	33 feet

Three conductors each 45 feet, as marked at 10 feet distance.

No. 34—or Allahabad No. 4.

Length.	Breadth.	Height
21 feet	7 feet	25 feet

The magazine No. 33 is within 69 feet distance, height 33 feet.

Two conductors, one between this magazine and No. 33, and one at the end both, 10 feet distance, and 40 feet high

No. 35—or Allahabad No. 5.

Same remarks as the last.

No. 36—Cawnpore Magazine.

Length.	Breadth.	Height.
110 feet	72 feet	23 feet

Surrounded by buildings at from 35 to 128 feet distance, and 20 feet high.

Digitized by Google

I would not consider this magazine to be adequately protected with less than 8 pillar conductors, each 40 feet high, placed as shewn at 10 feet from the walls, and all connected by a breast wall, and lateral straps of copper, much additional security would be gained.

No. 37—Saugor Fort Magazine.

Length.	Breadth.	Height.
84 feet	25 feet	32 feet

Surrounded by buildings, a battery with guns, but 15 feet to the east, and only 4 feet lower than the magazine; the other buildings are from 30 to 200 feet distant, one at 90 feet is 50 feet high.

1 Erect a pillar conductor on the battery

2 do. of 70 feet high of straps of copper, to be attached to the camp quarters.

3 A 40 feet do. to the Laboratory Offices; besides these, two 40 feet pillar conductors to the magazine itself. The bearings not being given, I cannot specify the best sites, but of course they would be chosen in the intervals between those of the other conductors so as to cover the magazine from all the points of the compass.

No. 38—Ajmere Magazine.

I have marked in the plan the number (9) and the places of the conductors, I would recommend.

The bastion conductors, may be 70 feet high of copper straps; between these a 50 feet strap conductor to the wall, all these three should be connected by a strap along the wall.

At 10 feet from each end of the magazines, a 40 feet pillar conductor, also one at the intermediate wall, and one at the north wall as marked.

No. 39—Agra Magazine.

Length.	Breadth.	Height.
125 feet	75 feet	34½ feet

Digitized by Google

At 15 feet distance north, is a building 59 feet high; at 38 feet S. E. one 48 high, at 52 feet one 65 feet high, viz. the Rampart and Gate: to the 59 feet building attach a 70 feet conductor.

To the Ordnance Godown wall one 60 feet high.

To the magazine itself, four independent conductors of 50 feet each, so placed at 10 feet apart so as to protect the intervals between the other conductors.

No. 40—or Agra No 2.

Length.	Breadth.	Height.
64 feet	59 feet	25½ feet

A rampart (W.) 41 feet high, at 26 feet distance—The China bazar E. at 62 feet, is 21 feet high. The Delhi Gate (N) at 115 feet is 84 feet 6 inches high.

Erect a conductor to Delhi Gate (N.) 90 feet high, one to western Rampart 50 feet high, and two of 40 feet to the magazine, to the east and south sides at 10 feet distance.

No. 41—or Agra No. 3.

Length.	Breadth	Height.
64 feet.	59 feet	25½ feet

Jehangeer Bastion (N.) 32 feet distance, 61 feet high. The rampart (S.) 98 feet distance is 35 feet high. The buildings at the other sides may be neglected.

Erect a conductor 75 feet to the north Ramparts, one to the south Rampart 50 feet high, two to the magazines E. and W. at 10 feet distance.

No. 42—or Agra No. 4.

Length.	Breadth.	Height.
225 feet	59 feet	25½ feet

None of the buildings mentioned are sufficiently adjacent to need notice.

A line of five 50 feet pillar conductors, at each of the long sides, and 10 feet distance, and two similar conductors at each end. If

Digitized by Google

all be connected by a breast wall, and copper strap, the height of all the conductors, but those marked thus ⊖ may be reduced to 35 feet.

No. 43—or Agra No. 5.

Length.	Breadth.	Height.
115 feet	59 feet.	25½ feet

The only adjacent building or object regarding notice, is the Rampart to the distance 40 feet, height 42. Erect a conductor of 60 feet to the Rampart (N.) and four or six conductors of 40 feet as marked in the plan.

No. 44—or Agra No. 6.

Length.	Breadth.	Height.
115 feet	59 feet	25½ feet

The nearest object is the Rampart to the north, 28 feet distance, and 42 feet high.

Attach a 60 feet conductor to this Rampart, and to the south east, and west sides, a pillar conductor at 10 feet distance.

No. 45—Delhi Magazines.

Length.	Breadth.	Height.
78 feet	44 feet	21¾ feet

To the north at 101 feet distance, the Armoury 40 feet high.

To the east, at 44¾ feet distance, a store room 17½ feet high.

To the west at 96 feet, a store room 17½ feet high.

Attach a 50 feet conductor to the Armoury (N.) The store rooms need not be noticed, to the Magazine give two 40 feet conductors.

No. 46—or Delhi No. 2.

Length.	Breadth.	Height.
56 feet	31 feet	28 feet

At 24½ feet (W.) a gun shed 15¼ feet high;—at 90 feet (S.) the next Powder Magazine 28 feet high.

Between both magazines N. and S, and equidistant, erect a 60 feet conductor, to the gun shed (W.) one 40 feet, to the north and east independent 40 feet conductors at 10 feet distance.

Digitized by Google

No. 47—or Delhi No. 3.

Length.	Breadth.	Height.
77 feet	41 feet	28 feet

A Powder Magazine (No. 46) distance 90 feet, height 21¼ feet; at 24 feet south, a store room 14¾ feet high.

See remarks on preceding Delhi Magazine for the intermediate conductor.

Affix a 30 feet conductor to the Store room to the south. E. and W. at 10 feet distance, give a 40 feet conductor.

No. 48—Meerut Magazine.

Length.	Breadth.	Height.
16 feet	16 feet	16 feet

Surrounded by buildings, one 18 feet high 12 feet distant; one 22 feet high, also 12 feet distant.

Attach a 30 feet conductor to each of these buildings.

No. 49—Kurnaul Magazine.

Length.	Breadth.	Height.
109 feet	39 feet	25 feet

The adjacent buildings need no notice.

Attach four 40 feet conductors, at 10 feet distance as marked.

No. 50—Loodianah Magazine.

Length.	Breadth.	Height.
34 feet	30½ feet	16 feet

The main Barrack to the west 18 feet high, is 55 feet distant. The Officers' Barrack of the same height is 123 feet distant. There is a wall at 8½ feet from the building 6 feet high. At the 4 cardinal points of this wall, erect a 40 feet conductor, and connect the four with copper straps along the wall.

No 51—Hansi Magazine.

Length.	Breadth.	Height.
45½ feet	35 feet	25 feet

Digitized by Google

The adjacent buildings may be disregarded

I would recommend four 40 feet pillar conductors, one at each corner, and 10 feet distance.

No. 52—Subathoo Magazine.

Length.	Breadth.	Heigth.
44 feet	18 feet	14 feet

The Fort is but 24 feet distant, and is 30 feet high, the bearings not being stated, I can only say that a 40 feet conductor at each end 10 feet distant, and one to the nearest part of the Fort, would give ample protection.

No. 53—Almorah Magazines.

Length.	Breadth	Height
31 feet	19¼ feet	15½ feet

The Artillery store room should have a conductor of 30 feet, and the Magazine have two; one at each end 10 feet distant, and 35 feet high.

No. 54—Almorah No. 2.

Length.	Breadth.	Height.
43⅓ feet	18⅓ feet	13¾ feet

The adjacent objects may be disregarded, erect 30 feet conductors, at 10 feet distant, as marked.

No. 55—Howalbagh Magazine.

Length.	Breadth.	Height.
43 feet	19 feet	14½ feet

The adjacent buildings and objects, need no attention; erect four conductors as marked in the plan.

No. 56—Lohughat Magazines.

Length.	Breadth.	Height.
44 feet	19 feet	11⅓ feet

The Guard room (N.) is 17 feet high, and but 13½ feet distant—The Engineer store room at 63 feet (S.) is also 17 feet high.

Attach a conductor to each of these buildings, and 35 feet high, and 2 conductors to the magazine at the East and West faces, and 30 feet high.

Digitized by Google

No. 57—OR LOHUGHAT No. 2.

Length.	Breadth.	Height.
16¾ feet	16 feet	11¼ feet

Adjacent buildings need no conductors, one conductor 10 feet from north end, and 35 feet high should suffice ; but a second would add much to the security of the magazine.

No. 58.—OR LOHUGHAT No. 2.

Length.	Breadth.	Height.
41½ feet	30¼ feet	18 feet

Adjacent objects need no notice.

Erect four 30 feet conductors at the parts marked in the plan.

No. 59—OR PETORAGHUR No. 1.

Length.	Breadth.	Height.
20 feet	16 feet	11½ feet

Adjacent objects, or distance of wall not specified. Two conductors each 30 feet should be sufficient. For No. 60 Petoraghur No. 2, the same should be provided.

CALCUTTA, 29th *Dec.* 1841. } (Signed) W. B. O'SHAUGHNESSY, M. D.
Assistant Surgeon.

FLANK GUARDS, AND PATROLS.

Every Officer and non-commissioned officer should know how to conduct a patrol and report his observations, and indeed every private should understand the object and business of such parties. Unless every individual of a patrol knows that it is a principal rule to see "every thing if possible without being seen," the duty cannot be usefully or correctly performed. Every man should be able to assist in remarking what may fall within the observation of the patrol, and although the particular instructions for the occasion are only known to the officer, or non-commissioned officer in

Digitized by Google

command, yet all should know what are the general duties of such parties. A patrol may consist of a subaltern's party, or of a serjeant and twelve, or a corporal and six men, according to circumstances. The object of a patrol is to obtain intelligence, and to ascertain the presence of an enemy. They are detached to examine houses, copses, enclosures, &c. near the line of march, and also to examine the country for the purpose of knowing its features, the roads, bridges, rivers, &c. &c. Every officer and intelligent soldier should accustom himself to look at a country he is passing over, and the objects about him, as though he was to report on them. By such practice he will find himself when called on to patrol, or questioned regarding any ground he may have passed over, able to give a clear and distinct account of what he has seen, and to give valuable information, when an unpractised man would probably have observed nothing. It is a rule that every patrol, if but consisting of six men, must have one or two sent in front some three or four hundred paces, and also on the flank towards the enemy or on both flanks if necessary, in order to prevent surprise. It is better that the commander of the party should have but one or two men left with him, than be liable to surprise and capture by neglecting these essential precautions. The detached men should report all they see, when they come in to the commander, unless they know what to observe, they cannot do this usefully, and therefore, too much pains cannot be taken to explain to the soldiers what may be required of them in the performance of these duties.—An officer or non-commissioned officer in command of a patrol, should be provided with pencil and paper, to note on the spot what he may observe.—The best memory cannot be depended upon to make a detailed report on the completion of the duty. When going upon any detached duty, an officer should take a most accurate inspection of his men's arms, flints, and ammunition; upon these, probably, the lives of himself and his people may depend. He should be certain that he perfectly understands his orders, and have explanations made of such points as he may think doubtful or ill defined. In so far as is necessary, he must instruct his men, that they may know how to act in falling in with an enemy.

Digitized by Google

He should observe strictly the country he traverses, and make notes:

1.—Of the roads, their direction, whether straight or winding, if good or bad, wide or narrow, how bounded, open, if paralleled routs can be readily cut on either side, if crossed by rivers, ravines or torrents.

2.—Of woods, their form and extent, whether thick or thin, with or without underwood, if passable for Artillery, or Cavalry, or Infantry, or quite impassable; the general size and kind of timber.

3.—Of marshes, their extent, and degree of impassability, whether periodical or permanent.

4.—Of rivers, whether navigable, and if so, by what kind of craft, if fordable or not: if not, where boats may be found, and in what number; whether the banks be steep or low, whether marshy or dry.

5.—Fords, their practicability for all arms, their depth, whether oblique to the course of the river or not, whether easily accessible; their breadth, their bottom, whether sand or mud, rocky or incumbered with large stones.

6.—The bridges, of what material, whether broad or narrow, their length, the depth of water, and whether fordable near; whether easily defended, and by what means; whether by commanding banks, adjacent houses, or mills, &c.

7.—The villages, farms, churches, country houses, their extent, population, the materials of the houses, their military position with reference to bridges, passes, fords, &c.

8.—Of the country generally, whether hilly or flat, if close or open, the nature of the fences, the agricultural rise, whether tillage or grazing; whether forage be plentiful and of what kind, &c.

The orders which an officer may receive, will, of course, draw his attention more particularly to the special object for which he may be sent out.

Secrecy is desired in patrol duty: the greatest vigilance will be therefore necessary to avoid discovery. This must be fully ex-

Digitized by Google

plained to the men, lest they should through ignorance and inadvertency, expose themselves to view.

Should a party of the enemy pass the place of concealment of the patrol, no temptation, not even the certainty of success, should induce the officer to commit himself in action.

If the object of the service be likely to be forwarded by the seizure of some prisoners or when circumstances may render fighting indispensible, then, prompt decision, coolness and rapidity of action, will compensate, for even a considerable disparity of numbers in which success is by no means principally involved. In war, as in mechanics, it is not the mere possession of power, but the judicious application of power which produces successful effects; and the head as well as the hand must fight. People of the country, and inhabitants of all classes should be questioned to obtain the required information; but much depends on those who put the questions, understanding their own business and knowing the exact sort of information required.

Questions should be put like the following—Where is the enemy's camp, or his cantonments? Where are his advanced posts? What are his numbers? What Cavalry, Infantry, Artillery? Who commands? Do they patrol much, and how; strong parties or weak? Are they particular in their examination of people passing their advanced posts? Are there no unguarded passes by which to get within their pickets? &c.

DESCRIPTION OF THE FORTS OF BEDAMEE, BY CAPTAIN F. BURGOYNE, MADRAS ARTILLERY, Fig. 23.

The two Hill Forts and town of Bedamee are situated on the west side of a range of hills north of the Mulpurba, and distant from it about 3 koss, and about 35 miles S. S. W. of its junction with the Kistna river. Latitude (by Hamilton) 15° 53′ 30″ north, and longitude 75° 48′ 40″.

The Pettah lies between the two Hill Forts which are situated as it were at the extremities of a crescent of hills formed round the rear of the town. The larger one to the north, and the other to the south of the town. A large tank is situated behind the town which is said never to be dry.

Digitized by Google

Pettah. Being situated between the two Hills, and running close up, is most completely commanded by them. There are two Pettah walls. The outer one which encloses the whole of the town and which runs from hill to hill, forming a most extensive front of more than 1400 yards facing the west. The other is within the former, and is situated round the foot of the larger Fort, it is not so extensive and has no ditch.

The larger wall is strong built with stone and mud, the parapets are loop hooled, small square bastions are placed along the wall, capable of holding Ordnance; there is a deep broad ditch round it, except at the points where it is connected with the two hills, where it is not very deep or wide. The defences on the east side near the tank are strong and well commanded by the two Forts.

Gateway to the Pettah. There is but one to each of the Pettahs, the great one into the larger Pettah, is situated on the west side, and contains 3 gates, the works round which though somewhat dilapidated, are still strong and capable of making a good defence against an attack on that quarter.

The inner Pettah also has only one gate of no great strength, but the entrance is exceedingly well commanded by the lower works of the north Fort.

The large Fort to the north called Bavanbandal or "Fifty rocks." Is of an irregular oval form, and constructed on large broken rocks, which are separated from each other by deep perpendicular chasms, in some places of 100 feet in depth, and not 20 feet broad, these are connected with masonry, and defended by circular bastions at unequal distances of great strength, but placed with great care in the most commanding positions. The deep chasms offer good protection (from their being so narrow) from shells, and also from having good pathways, contain excellent means of communication to the different parts of the Fort, some of them are exceedingly narrow and steep, and could easily be defended by a resolute garrison.

The defences on the north face are of strong masonry built on the natural rocks, which here and there are seen projecting from the walls, its appearance has a more regular and finished form, than other parts of the Fort; as it is, a continued line of defence

Digitized by Google

containing curtains flanked by bastions of strong stone work. To the north east is a bastion situated lower down than any other part of the defences, and more accessible to an attack, by escalade than any other, it is about 25 feet high.

The rest of the defences of this Fort, especially towards the Pettah, are a series of works built irregularly according to the nature and character of the rocks, consisting of walls, all of which are capable of containing Ordnance. The positions are selected with great care, and are capable of being well defended.

Gates. There are several gates and doorways to be passed before reaching the upper part of this Fort. After entering the lower Pettah at the foot of the Fort, there are three gates all commanded by the lower works within 60 yards distance. After which a very small doorway (4 feet by 2½) is to be passed (fig. 28) this leads into one of the deep chasms above mentioned. The space round this door is well flanked by works loop holed, and the door being so very small a few stones inside would be sufficient to block it entirely up. The chasm is very steep and narrow, and might easily be defended by a few determined men. After going some distance up this passage another doorway presents itself, built of very strong masonry, this is the last, and leads at once into the upper parts of the Fort, but even here such is the nature of the rock, that though to all appearance the place is clear of obstructions yet deep and dark chasms are sometimes come upon unexpectedly which completely stop further progress.

There is but little clear space within the Fort, except in the centre near a large powder magazine, and then only about 120 yards square.

This Fort contains 4 tanks, three small ones, and one much larger, which is said never to fail as it is supposed to contain springs, however the ruins of an aqueduct would lead to the supposition that there must sometimes be a scarcity of water.

This Fort is very small and situated to the south of the Pettah, and about 350 yards from the larger one, it is constructed at the very point of the range of hills to the south and on a very large bluff rock nearly perpendicular on the Pettah side. The Fort is cut off from the range of hills by a chasm which forms a natu-

Digitized by Google

Digitized by Google

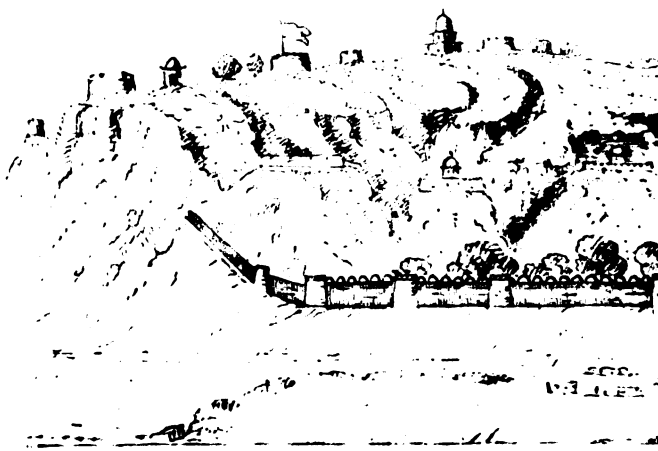

Lieut. Allan 4th N.Y.
40 men.
Irregular
Infantry.
Irregular
Infantry.
35 men.
Irregular
Infantry.
Lieut. Richmond 4th
80 men.
Water
Irregular
Horsemen.
Art'y Depôt.

Digitized by Google



Digitized by Google

Digitized by Google



Art.ᵉ Depôt

Digitized by Google



HILL F

Digitized by Google

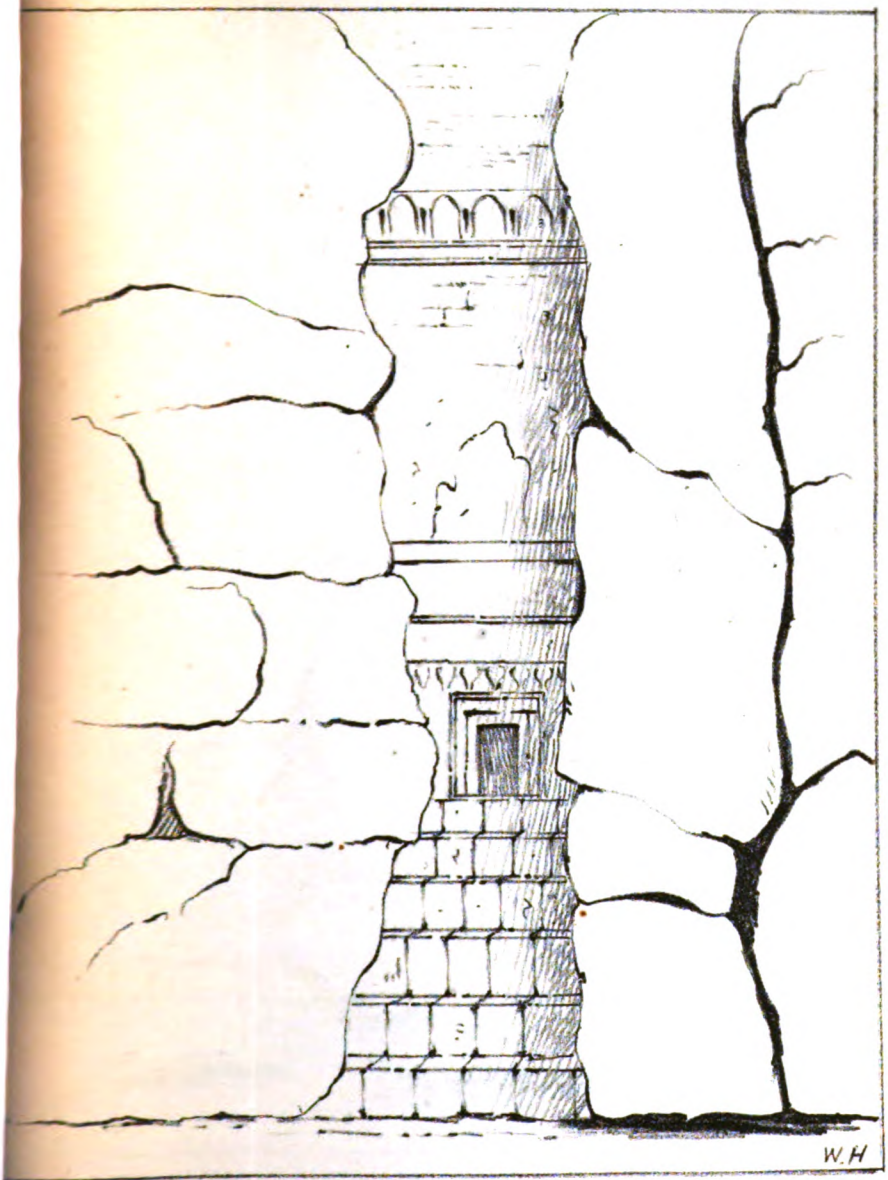
W.H

Wd,
high

Digitized by Google

Miscellaneous.

fig 25



First Gate into the smaller Fort, which was shell'd, dimensions 4 feet high 2½ broad, steps about 2 feet high 6 or 9 inches in depth, some higher.

Art^y Depôt

Digitized by Google

Digitized by Google

Miscellaneous.

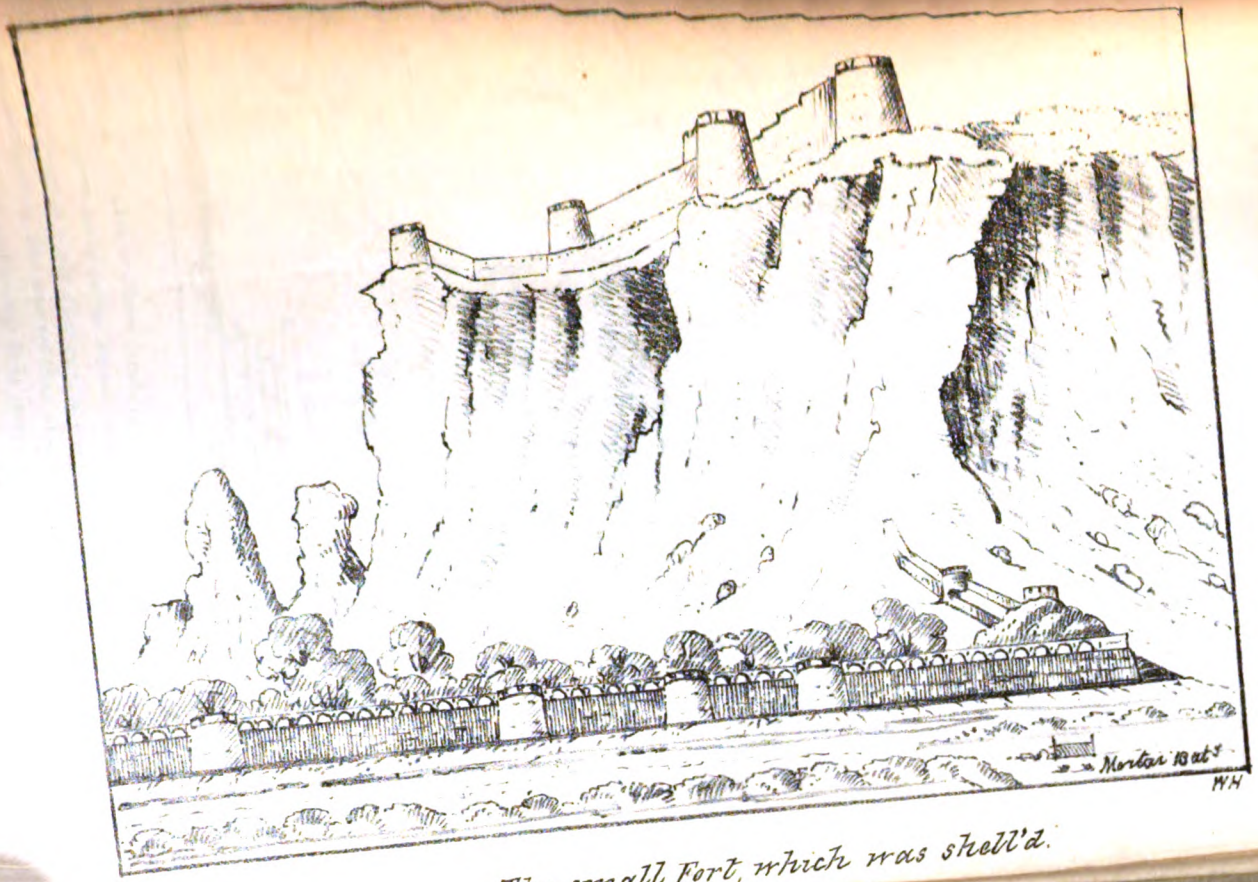
fig. 26.



The Passage up to the small Fort, on reaching the top, the small door way (fig. 25) is to the right. There is also another gate or door higher up, of the same dimensions, behind which were large stones ready for blocking it up.

Digitized by Google

Digitized by Google



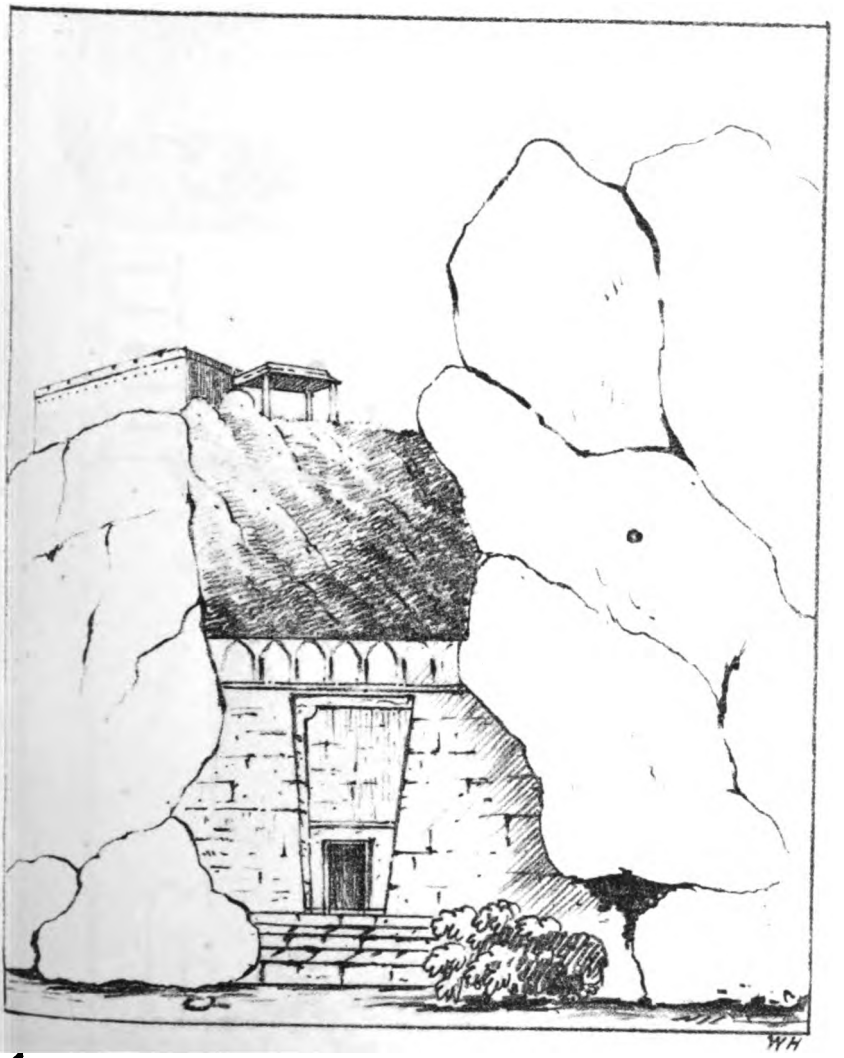
The small Fort, which was shell'd.

Digitized by Google

Digitized by Google

Miscellaneous.

fig 28.

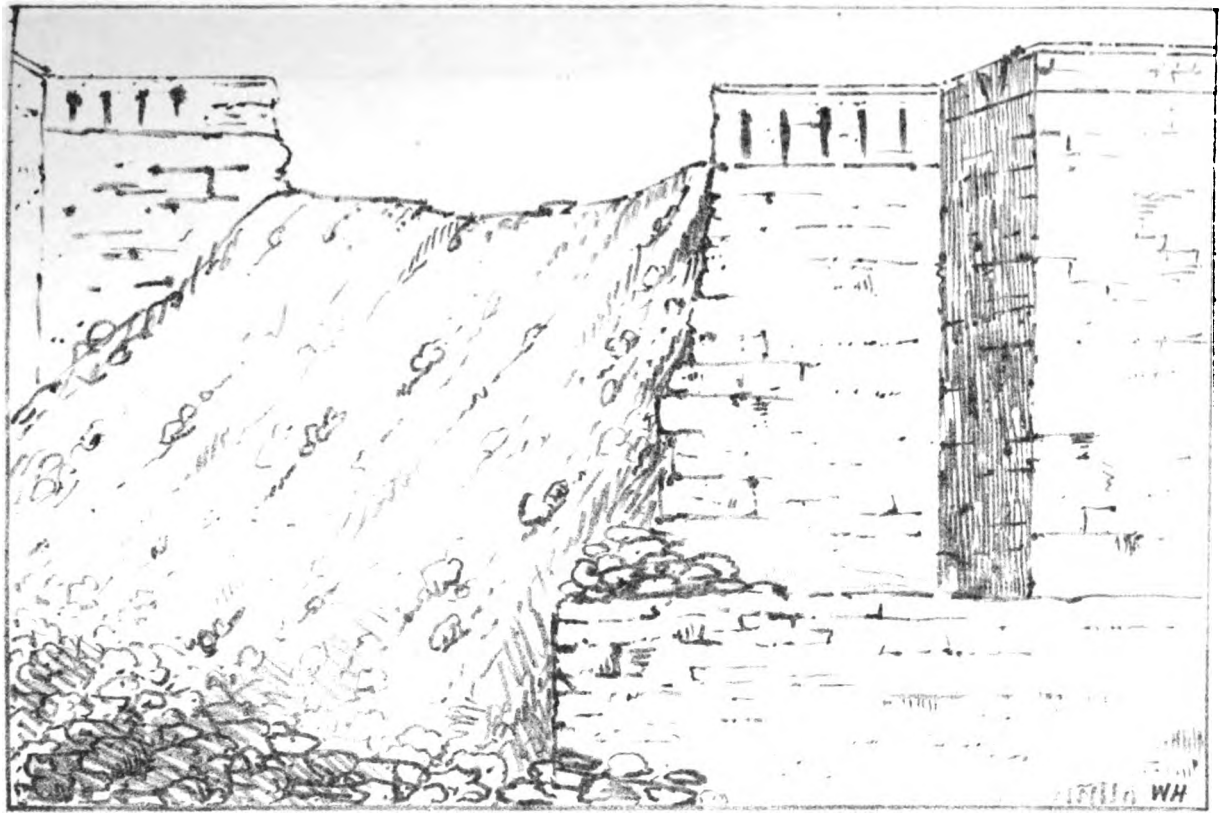


One of the Gates or Doors leading up to the large Fort, dimensions 4 feet by 2½. There were large stones ready inside to block it up. There was another strong Gate (larger) higher up. There were also 3 Gateways before reaching the one in this sketch, which were well flanked by works loopholed. on entering this door, the path is up one of the deep chasms very narrow, steep and easy commanded.

Arty. Depôt

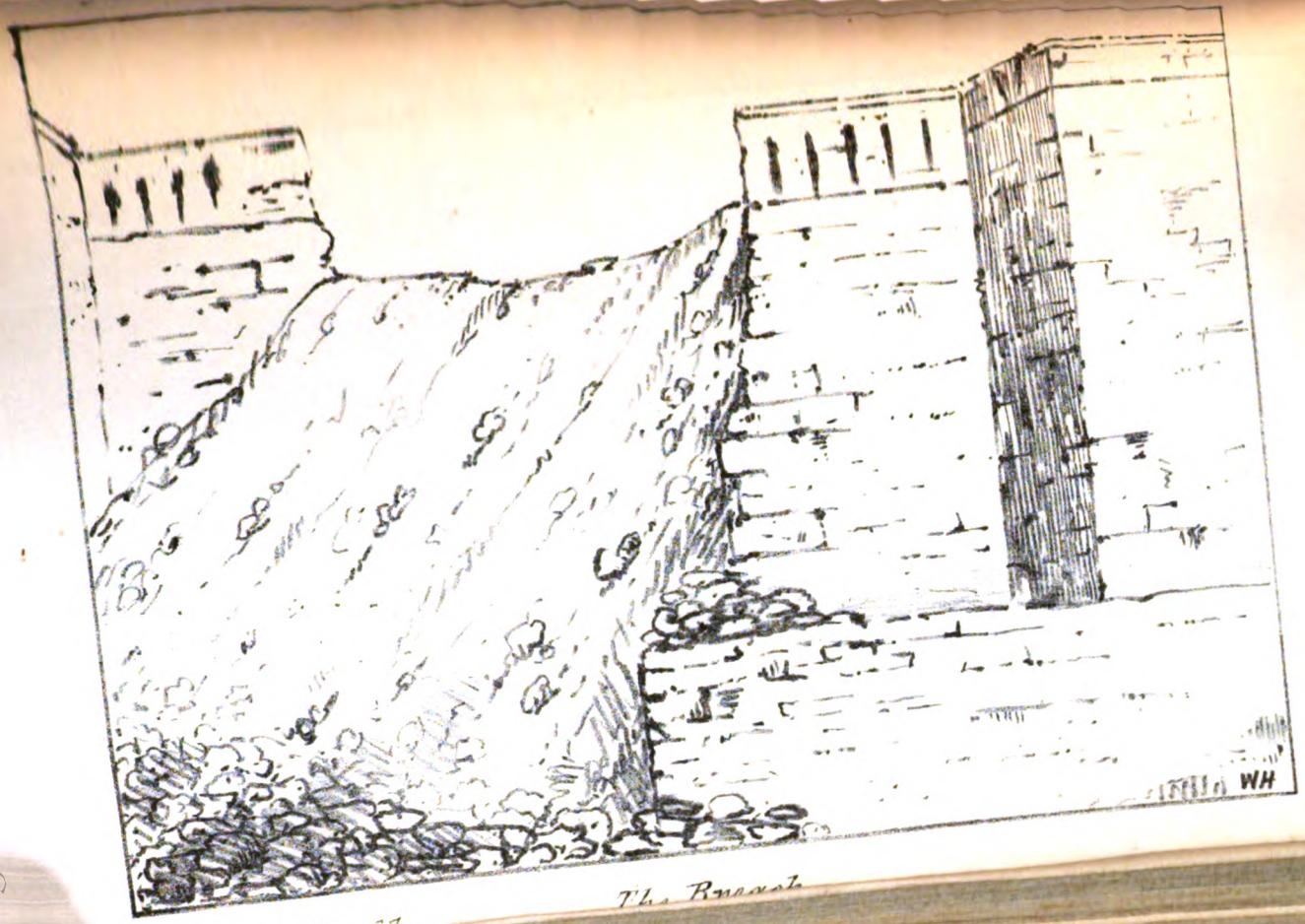
Digitized by Google

Digitized by Google



Digitized by Google

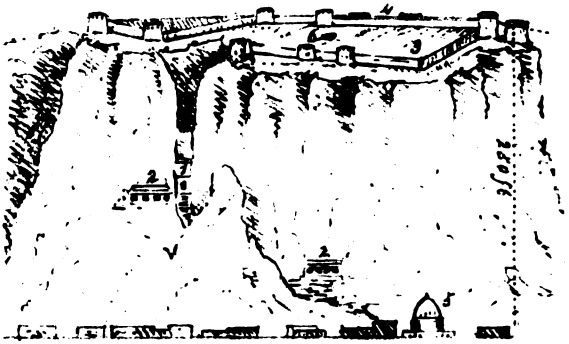
Digitized by Google



Digitized by Google

Digitized by Google

Digitized by Google



Digitized by Google

·two
fitch
:h it
tain-

eed-
ault,
be

(fig.
p of
loor
o be
feet
ngly
feet
tion
ime
ndi-
ther
sage
hich
the
this
per-
sms
nt is
naps
it to

)rd-

\

:ms,
part
ased
were
: so

Digitized by Google



Digitized by Google

ral ditch to the south and S. E. front. The Fort consists of two works of very strong masonry, one is the fort itself next the ditch or chasm, with an out-work between it and the Pettah which it completely commands. The Fort is of an irregular form containing curtains flanked with strong circular stone bastions.

The entrance to this Fort from the Pettah is by nature exceedingly difficult, and by art it is rendered impregnable to an assault, indeed it is one of the most curious defences which can be imagined and worth the attempt of a description.

The first ascent to this Fort is up a flight of steep steps (fig. 26) very narrow and easily defended. On arriving at the top of them, a turn to the right shews the entrance through a small door 4 feet by 2 (fig. 25) built of strong masonry, and which is to be reached by going up a very steep flight of steps about 2 feet high and 8 or 9 inches in width, thereby making it exceedingly steep, the doorway leads into a small space not above 3 or 4 feet square; immediately in front, are steps of the same description which do not allow of more than one person to ascend at a time from their being so narrow. The sides of the rocks are perpendicular to a great height, having climbed up these steps, another very small entrance presents itself which is a low confined passage with a doorway (where a wall is built across the chasm) at which only one person could get in at a time and that with difficulty, the body being necessarily bent to admit of its passing through, this place as well as the first door could be easily defended by one person. The whole passage is through one of the narrow chasms which forms the peculiar feature of the two Forts. The ascent is tedious and difficult, and descending looks a serious affair, perhaps the most correct simile that can be given to it, is to compare it to a deep narrow well.

These Forts in the hands of a resolute garrison possessing Ordnance, might make a very protracted defence.

HAND GUNS.

The Protector Somerset, aware of the importance of fire-arms, had above 3,000 foreigners in his pay, of whom the greater part were musketeers. In 1555, the Spaniards are said to have used them under Philip II (and at this period the Spanish Armies were still considered the finest in Europe); but these muskets were so

Digitized by Google

heavy that they could not be presented without the assistance of staves shod with iron, having a fork at the top to rest the barrel on, various attempts were made to convert this rest as a defence against Cavalry, while the musketeer was loading, by affixing a spike to the head, or enclosing a short dagger in the shaft, so as to fly out on touching a spring. Rests thus armed were called "the Swedish or swine's feathers." These muskets at first had no lock whatever, but were fired like cannon by applying a lighted match. When they were reduced in weight and improved by the invention of the *match-lock*, so that they could be discharged from the shoulder without rests, they were called, *calivers*, the old muskets being confined to sieges, and resembling the arms now called *wall-pieces* which are still used in India. The caliver appears to have been intermediate between the musket and the arquebuse: by a passage in Shakspear it seems that calivers were used in his time for shooting wild fowl: Falstaff says, speaking of his soldiers "such as fear the report "of a caliver worse than a struck fowl, or a hurt wild duck." Many writers consider the arquebuse to be the most ancient fire-arm mounted on a stock and place the invention of it about the year 1500; it succeeded the hand cannon or culverins which were afterwards called arquebuse a croc (arquebuse with a hook) in consequence of being cast with a little hook on the piece; they were placed on tripods and used in the lower flanks, and in towers pierced with loop-holes, called murderers (muertrieres). Hanzelet describes it as a short fire-arm, which carried a ball of 1¼ oz. and the length of barrel 40 calibers. In our ancient statutes it is called "arquebuse," "haquebut," and "hagbut," formed of the French word *arquebuse*, which is derived from the Italian *arco*, a bow, and *bugio*, a hole, because when guns were first used, a bow was joined to the same stock that served for these fire-arms, which appear to have immediately succeeded the ancient cross-bows. The larger kind or arquebuse a croc, required two men to carry them, and were first seen in the Imperial army of Bourbon, which drove Bonnivet, out of the state of Milan. These were fired by means of the pyrites wheel-lock, which was introduced about the reign of Henry VIII, and continued in use until the time of Charles II. It is supposed to be of Italian origin.

Digitized by Google

A PROPOSAL, FOR INCREASING THE STRENGTH OF THE "INDIAN ARMY," &c. BY CHANGING ALL THE GUNS, FROM THE EIGHTEEN POUNDERS DOWNWARDS, INTO OTHERS OF GREATER BORE.

By P. ANSTRUTHER, Captain, *Madras Artillery.*

*Periissem ne Periissem.**

The necessity of diminishing the weight of the battering trains is so universally admitted amongst the Indian Artillerists that I feel it is quite unnecessary to point out the cases in which sieges have been raised, campaigns prolonged, by reason of the insufficiency of the train, caused by the impossibility of supplying cattle to draw such ponderous masses as our guns, in sufficient number.

That we still continue to use these uselessly heavy machines, is to be attributed chiefly to the great difficulty which our organization in three separate Regiments throws in the way of any general adoption of an improvement, and perhaps still more to the fact that all Artillery questions whatever are referred to the Court of Directors at Home, who decide upon the measure as they are advised to do by the superior officers at Woolwich, whereby the advantage of local experience is wholly lost.

Still more do we owe our almost hopeless continuance in error to the habit which all Artillerists, more or less, have permitted themselves to fall into, of admitting extraneous considerations to influence their decisions on points which ought to have been kept quite clear. A few of these I will here advert to, in order that my readers may in the outset understand clearly that in the following attempt to shew how our trains may be lightened, I will try to answer all objections which I can foresee, but to answer them in their right places and not permit them to influence my decision on matters to which they are wholly (or nearly) irrelevant.

For instance.—A. proposes a light gun for use, B. objects that

* The Reader will find that the above is a *fac-simile* of that prefixed to a paper by the great Robins, read to the Royal Society on the 2d of April 1747—about three years before his arrival at Madras.

His removal to India, is probably the reason why no effect was produced by this paper, the opinion of this great Father of Artillery Science being unattended to by the now-forgotten heads of the Corps who were his cotemporaries.

This paper will be found bound up with Hutton's Edition of Robins's Gunnery, London, 1805, from Pages 279 to P. 294 to which I refer the Artilley reader.—P. A.

Digitized by Google

it will recoil too far. It is quite clear that this is not an objection to the *gun*, for the recoil is the retrograde motion of gun *and* carriage, the addition of weight therefore or different placing of the weight may alter the carriage so as to do away with the objection. This then is an objection not relevant to the question, which was, light, or heavy, *gun*. Or take C.'s objection, who says, that A. to lighten his gun has cut away from the muzzle so much that the breech will preponderate overmuch, and the result will be a difficulty in limbering up. Here C. has also urged an objection to the gun which rightly belongs to the carriage. For suppose the axle to be placed 3 feet farther back on the trail than it now usually is, is it not clear that the whole of the gun's weight being in front of the axle the muzzle would fall, the breech and trail rising in air? But if changing the relative position of axle and trail obviates this objection it is clearly one relating to the carriage, and not to the gun. D. objects that the short gun will blow away the embrasures. But this objection does not hold in a barbette battery, or in open field, it is therefore merely an opinion that in certain cases it may not be compatible with the old pattern of batteries. E. says a long gun is good to clear the rigging of vessels by the projection of the muzzle. The reply is that either by using Commander Pole's carriage, or by bringing the rigging in decks, this objection is overruled, it is therefore not strictly speaking relevant to the question "light or heavy *gun*." B. C. D. and E. have alike avoided the real question, and complicated the subject by introducing extraneous considerations.

To be of any practical use to the Indian Artillery, the question to be solved is, how may the guns now in store, be so lightened as to produce the same effect as at present, with the greatest possible reduction of weight. It is no part of my subject to consider what would be the best figure that can be given to an iron battering gun, in any future casting, I limit the discussion to the simple question, how should the iron guns now in store, be so altered as to throw the iron shot now in store, with the greatest possible reduction of weight unaccompanied by loss of force.

There are only 3 possible modes of reducing the weight of an iron gun, viz. cutting away from the muzzle, boring out from the interior and turning off from the exterior.

Digitized by Google

We will first consider very briefly the effect of cutting away from the muzzle.

Let 2 guns of equal length, weight and bore, be placed in battery with equal charges of powder, they produce equal range.—Now from gun No. 1, cut away one-third of its length.—As I am addressing Artillerists, I need not stop to enquire why the gun so cut short does not throw its shot so far as gun No. 2 which retains its original length, suffice it, it does not. What follows?

The Officer in charge of No. 1, increases his charge of powder until he does obtain the same range as the long gun at equal elevations, and he says that whatever charge he uses to obtain this, he may use with perfect safety, as it is quite evident that until the ball is thrown to an equal distance, the shock communicated to the breech, the danger of bursting cannot possibly be equal.

For, effects are as their causes—until effects are equal, causes cannot be so, and the shock given to the breech may be exactly estimated by the effect produced upon the shot. If the short gun required 5 lbs. of powder to throw its shot as far, at equal elevation as the long gun did with 4 lbs. these two charges of 5 lbs. and 4 lbs. should be termed equal, as measured by their effects on shot, not their bulk or weight. They are equal "forces."

We may therefore most fearlessly give such increase of charge to a gun cut short, as will produce equal ranges with those obtained from the gun before cutting, in the perfect certainty that, whatever the increase may be, we are only communicating to the metal the same shock as formerly, and therefore only incurring the same risk of bursting.

Here I wish my reader to pause and be quite sure that he agrees with me, as upon this point, turns the whole of my argument, I will merely advert to one objection, a trifling one: A friend has pointed out that there is a limit of length of charge, after which increase becomes useless, as the powder is blown out unignited. But as I only propose to consider the guns in use with land forces, 24, 18 and 12 pdrs. this may be disregarded, as of course no such extreme length of charge will ever fall to be considered. I consider the above proposition to be quite clear and

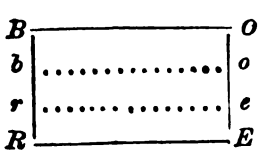
Digitized by Google

undeniable, but its fair and legitimate deductions lead to such startling conclusions that I must caution my reader to make himself as sure of this point as I feel myself. Then let him accompany me.

Note.—Whether *length* does not greatly diminish strength, by allowing of *vibration*, producing disruption, is a consideration worthy of attention. A long bar of cast iron suspended between two points of support, will, if struck violently at one end, break at the opposite end, manifestly from the checked vibration; being without data upon this point I merely throw out the hint for the consideration of my reader. It is evident that a mortar cannot vibrate like a gun of 9 feet 7 inches.

The next mode of lightening a gun is boring out from the interior, and the last turning off from the exterior—the first of these two I propose to consider in some detail, the latter we may dismiss altogether as not recommended by any one. It will be better however not to consider boring out in relation to *lightening* the gun merely by the metal taken out, it is by affecting the windage, that boring out authorizes cutting away from the muzzle and thus most materially lightens the piece, although the mere metal taken out in boring is very little indeed.

Let us examine how this acts on the length of the piece. We have seen that we may safely give the same range, the same velocity, as formerly to a gun which we have cut short, but the accuracy with which a gun throws its shot depends in some measure on length. Suppose *BORE* a cylinder in which a sphere is to travel, the difference between *B R* the diameter of the cylinder and (2 *Bb*) the diameter of the sphere will be the windage. Parallel to *BO* draw *bo* at such a distance as that *Bb* shall be the semi-diameter of the sphere and parallel to *RE* draw *re*, with *Rr*=*Bb*. The interior rectangle *bore* will be a section of a cylinder, whose length is that of the bore and diameter equal to the windage. Out of this cylinder the centre of the shot cannot pass.



Digitized by Google

Now the shot in its passage along the cylinder is acted upon by a constant force, and supposing any deflection from the perfect line of axis of the cylinder, at the commencement of the shot's travelling, it would describe a zigzag somewhat similar to the approaches to a Fortification. The number of these deflections will of course depend upon the proportion between *br* (the windage) and *bo.* the bore.

If then we can diminish the windage we may diminish in exactly equal proportion the length of bore, without forfeiting accuracy, and we have above seen that we may diminish the length without any fear for velocity or range. Now the only way to diminish the windage so as to use the immense quantities of shot of the old size which now stock our Arsenals is to ream up every gun to the next higher calibre, a thing which every day's experience shews may be most safely done, retaining so much metal as that the windage should be very small.

What the amount of windage should be, would be advantageously discussed by experienced Indian Artillerists and fixed upon grounds which should be published to the Artillery at large.

When the Royal Artillery Select Committee took the subject into consideration in 1817 they determined, for reasons never published, that the windage for field guns should be ·1, and that for garrison guns ·15, at least this was published to the world as their decision, but, a comparison of the shot then in use and now, shews the difference of windage to be as follows :—

	Previous to 1817.			Fixed in July 1839.		
	24	18	12	24	18	12
Shot's size. { high	5·639	5·124	4·476	5·63	5·12	4·47
Shot's size. { low.	5·584	5·074	4·432	5·58	5·07	4·43
Gun's bore	5·823	5·292	4·623	5·82	5·29	4·62
Windage ... { high	·184	·168	·147	·19	·17	·15
Windage ... { low.	·239	·218	·191	·24	·22	·19

The latter part of this table is quoted from the Artillerists Manual, published July 1st 1839, by authority—and it shews that no real diminution of windage has taken place in the three useful

Digitized by Google

field Battering Guns, and what the better are we for the fact, that to their 8 inch Guns the Royal Artillery only give ·1 or ·15 of windage? When do we draw 68-pounder Guns? The practical fact is that no reduction has taken place in the windage, and the Committee when they determined that the reduction should take place "as the shot in store was consumed," must have known that for the Indian service they were postponing an admitted improvement for at least 150 years. It is then absolutely necessary for the Indian Artillerists to bestir themselves, and induce our Masters to believe that with education equal, and opportunities, and local experience superior to the Woolwich authorities, it is for the Indian Officers to say how high the standard of windage should be fixed, and how the benefit should be immediataly conferred on the service which 22 years ago we were promised.

Let all the shot in our Arsenals be well cleaned and gauged. It will be found of course to have lost some trifle, but in no case to have gained, and I suppose will measure about 5·574 for the 24-pounder ·5·06 for the 18, and 4 418 the 12-pounder. This is of course a mere guess, as far as regards the 24-pounder and 12-pounder, the dimensions of the 18-pounder is that which a late experiment at Woolwich shewed to be the average diameter of the shot in store.

An Indian Artillery Committee would now say "what is the minimum windage which can be allowed." They would find that the 18 pounder carronade in the Royal Artillery only allows ·04 to the high gauge and ·09 to the low, having a bore of 5·16 and this they would fix upon without any reference to expansion at white heat or any other consideration. Perhaps 5·14 even would be better, for cleaning must eventually diminish the size of shot, and increase the bore, but nothing will ever enlarge a shot, kept tolerably clean, or diminish the bore.

The exact bore is not however matter for present discussion. The Committee would decide on that, keeping to the principle of admitting as little windage as possible, and then comes the most important consideration, how much may we reduce the length? We have seen that as far as regards mere velocity, any reduction may be made, and, that as regards accuracy, the proportion between

Digitized by Google

length of bore and windage must be kept the same to ensure equal accuracy of direction, we may therefore say as the former windage, was to the length of bore so is the present windage to the length of bore necessary. I need hardly point out to Artillery officers that the length of bore must be measured from the muzzle to the centre of the shot when in its place, which for an 18 Pr. of 9 feet length is about 88 inches, the semi-diameter of the shot and the cartridge taking up the remaining 14 inches of the bore.

Then as	· 17	:	88	::	· 04	:	27
or	· 22	:	88	::	· 09	:	36

giving 27 or 36 inches as the bore necessary, to which adding the 20 inches of metal behind the centre of the shot, we get 47 or 56 inches necessary length of gun. The former of these would cut away the trunnions, the latter will barely clear them, a few inches must therefore be left, and it will be found that six inches will not greatly encumber the gun, though doubtless less might serve all useful purposes.

We have now got a Gun, of equal accuracy and velocity with the old long gun, very much lighter although certainly not quite so strong, and the question occurs to every Artillerist, is it strong enough? This is the next point to be considered and I shall state my reasons for thinking that it *is* so.

The great Robins proposed in 1747, that each gun in the Navy should be reamed out to the next higher calibre, and gives his reasons for being confident that there would then be metal enough.*

We find that the Navy have for a century at least been in the habit of firing the iron guns which it is proposed to alter, double shotted. Lt. Beauchant in his "Naval Gunner" giving us the rule "Two shot range half the distance of one with the same charge and elevation."

Now as no land Artillery Officer ever intends firing double shotted, we may fairly ask whether my reduced gun will not bear a single shot of higher calibre better than it bore 2 of the lower when the metal was thicker.

* Vide note page 137.

Digitized by Google

But we find that the guns in actual use are some of them not thicker than the reamed out guns which I propose. In the Royal Artillery they have a 32 pr. gun of 6 ft. in length weighing 25 cwt. which is fired with 4lbs. of powder, with a windage of ·10 or ·16. A gun of 25 cwt. in 6 feet of length has 39lb. weight of metal in each inch. What the weight of the reamed out 18 pr. may be I have not the means of saying with accuracy, a 12 pr. gun, cut from 9 ft. to 5 ft. 2½ inches, and reamed out to throw 18 pr. shot will weigh exactly 24cwt. 2qr. 14lb. being 9½ inches shorter and only 42lb. lighter, it has evidently more metal than the 32 pr. just now quoted, in fact it has 44·128lb. metal in each inch, and as it is round a cylinder of 5·16 and the other 6·3 it is quite evident that the 18 pr. is an incomparably stronger piece. I cannot therefore anticipate that any Artillerist will hesitate to give the one gun 5lbs. of powder and an 18 pr. shot, rather than to a weaker piece 4lbs. of powder and a 32 pr. shot.

I will now quote from Capt. Simmons's able work, page 56, as follows:—Woolwich, 18th April 1776, "A 12 pr. weight 29cwt. 1qr., length 7½ feet, was bored up to an 18 pr. and then weighed 28cwt. 1qr. An 18 pr. weight 40 cwt. length 9 feet was bored up to a 24 pr. and then weighed————————————eleven rounds were fired from each gun, the 12 pr. charged with 9lbs. of powder and nine 18 pr. shot. The 18 pr. with 12lbs. of powder and ten 24 pr. shot. They were subsequently proved, in the usual manner by the proof master, and again fired 45 times with the above charges and the same number of shot, that is as many as they could contain. The guns were then carefully searched and not the least flaw or defect could be discovered in either of them."————Here the reamed out 12 pr. carried 9lbs. of powder and 162lbs. of shot 56 times fired! The long 18 reamed up was fired also 56 times with 12lbs. of powder and 240lbs. of iron!

I only ask for the reamed out 12, 5lbs. of powder and 18lbs. of iron, and pledge my professional character on its equalling any 18 pr. in the service, using 6lbs. of powder and the same shot.

I have now detailed a few reasons for thinking that the reamed out gun would have sufficient metal, and therefore strength, to

Digitized by Google

bear a charge fully sufficient to give velocity equal to that which the present long and heavy gun gives, with a reduction of $\frac{17}{4}$ of the weight. I think that the advantages gained by this great reduction of weight, are far greater than those which would result from the adoption of a larger shot as intended by the Royal Artillery Committee of 1817.

I need not to an Indian Artillerist point out, that in our enormously long teams of cattle much animal power is wasted by the mere length of the team, and this falls particularly heavily on my own Regiment, as the Bullocks of our country are so inferior to those of Bengal or Bombay. I make no doubt that one-third of the number of cattle employed in drawing a gun of the present pattern would with ease draw mine, and we should thus be enabled to put three times as many guns in Battery and consequently breach in $\frac{1}{3}$ of the time.

And when it is remembered that this great reduction of weight is the legitimate consequence of a reduction of windage which all confess to be necessary, I hope that the reasons I have assigned, for believing the reaming out by which alone we can enjoy the benefit of the reduced windage, to be safe and advisable, will be admitted and acted upon.

Having now finished the consideration of the question proposed, viz. how should the iron guns now in store, be so altered as throw the shot now in store, with the greatest possible reduction of weight, we will turn to the carriage; in the course of investigating the proper principles on which this should be constructed, several of the objections brought against the gun (altered as I propose) will be disposed of; and I hope to shew as great a reduction in this portion of the materiel of our service as in the gun itself.

The amount of reduction in the weight of our carriage will be astonishing, provided we commence by establishing the principle that nothing but wrought iron shall be used throughout, a principle which I hope, nine in every ten Indian Artillerists will at once approve, and which I think the majority of the Royal

Digitized by Google

Artillery Officers also would join in, but which the Select Committee at Woolwich, on the 15th of July 1839, denounced in the following terms. " It has already been ascertained that wrought iron carriages are totally destroyed at once by shot striking them, the introduction of such carriages therefore is inadmissible in the Royal Artillery and Naval Service."

Now I am quite confident that wrought iron carriages will be introduced in every Artillery, but certainly not until the adoption of so superior a material is turned to its proper use, viz. diminishing as much as possible the *bulk* of our carriages. It is really astonishing to see how Capt. A. Thiery in his "*Applications de Fer aux Constructions de l' Artillerie*" overlooks the principal benefits derivable from the very measure which he recommends. Let us for a moment turn our attention to the series of blunders, arising from the original error of using the wrong material, which have conspired to cause the present bulky, weak, ponderous machine called a gun carriage. The constructor had a gun of enormous weight to raise on wheels, and imagining that of necessity he must give high wheels to ensure ease of draught, he found himself obliged to give corresponding breadth of base, i. e. length of axle. He now found it necessary to add a trail to support the breech, and as the axle was so lofty, and it would not do to have this trail at too great an angle with the ground he was obliged to give length of trail. But the length of the trail so greatly weakened it, that it was found necessary to use a most enormous beam, and as the wretched material of which it was composed would be greatly weakened by perforation or deep cutting, the whole thickness of this huge beam was placed between the gun and the axle. This raised the gun to a most unnecessary height, and rendered a corresponding increase of breadth of base necessary, in other words a longer axle. The axle thus lengthened was of course weakened and broke. To give it strength it was bedded in wood, thus raising the gun still higher, and causing the trail and axle to be at once made longer, heavier, and weaker. Hence the necessity for enormous trains of cattle, &c. &c. to draw the ponderous machines, large establishments of carpenters, to construct them, depots in which to season timber, gun sheds to secure the

Digitized by Google

fabrics from the weather, and a train of expensive and useless appendages, so onerous to the state that no Government has yet kept half the due proportion of Artillery, because it is supposed to be the most expensive arm, while in reality, it might be justly termed the cheapest if rightly managed.

We will now briefly consider the proper principles on which Gun carriages should be constructed, and first assume that the strongest material possible shall be adopted, if gold were stronger than iron, I would not hesitate to affirm that true economy would use *gold* rather than timber! and in fixing on the material of which we mean to make use let us get rid of the idea of having it shot proof.

The idea of having carriages that cannot be destroyed by shot striking them, is a magnificent conception but impracticable. Be it our study rather to make a carriage all the parts of which shall be easily exchanged, as small as possible, as durable as possible and as cheap as possible, and which shall be but little diminished in intrinsic value even in case of a shot striking them.

So shall we be enabled to bring into every Field of Battle the heavy train, which now forms so heavy an item in the total expense of a war. Yet it is hardly ever within a hundred miles of a pitched battle, and for the want of it the Indian Armies, will again as at Mahidpoor put six 6 prs. to silence the fire of forty 18 Prs.———if they can!

Let us now set to work to consider the question "How shall we construct, of wrought iron, the lightest carriage of sufficient strength for the use of cannon?

To solve this easy question, inquire first what considerations limit you in reducing bulk. The first and foremost of these, is that there shall be no difficulty in looking over the gun, spunging it, and managing it. Any man may satisfy himself in a moment that if the line of metal be 40 inches from the ground, he will have no difficulty in looking along it.

Should any object that this is too low for Battery work, let me remind him that by giving a little more depth to the sleepers of

Digitized by Google

the platform, he will for very slight increase of weight gain some additional inches, and that it would be quite easy for a gun whose line of metal was only 40 inches from the plane on which it stood, to be 50 inches above the plane on which the men stand. But this is not likely to be urged by an Artillerist as an objection to so immense a benefit as the reduction of weight which I can offer him.

Now if the upper line of metal is to be 40 inches high, deduct the diameter of the gun at the part which you intend to place over the axle, and half the diameter of the axle and you will have the maximum radius of the wheels. But as it will be desirable that the axle should be varied, in its place on the trail, according to the service required, an inch or two may be allowed between the Gun and its axle, but not more. I have found that giving a radius of 21 inches to the wheel, raises a 12 Pr. to a height of 44⅛ inches, measured from the line of metal to the ground, which is unnecessarily high, but it was desirable to shock established prejudices as little as possible.

Having thus established the minimum height, the breadth is easily obtained. It has been found necessary, to ensure stability that a certain proportion of breadth of base, should be allotted to a certain height of the centre of gravity. Preserve the proportion ——— (here we must be cautious not to fall into the error of supposing that it is the proportion between the height of the *wheels* and the breadth over wheels, that gives stability, it is evidently as I first stated the height of the centre of gravity of the mass, gun and carriage.)

Should you find that there is not room for the width of the gun from the outer extremity of one trunnion to the outer end of the other, between wheels placed so close as yours will be by this rule, cut boldly from the ends of the trunnions. The trunnions have been made of their present length because a considerable thickness of the wretched material now in use, was necessary to give strength, besides which the warping, decaying nature of the carriages made it quite uncertain on what part of the trunnion the resistance of the carriage would act. When by the decaying of the interior of the wood, the stress came on the end of the trunnion, it of course

Digitized by Google

snapped off, and the gun was destroyed, we, meaning to use iron, need have no fear of this, an iron cheek need not be more than 2 inches thick and will be screwed close to the gun so as to ensure its receiving the shock of the trunnion, quite close to the junction of gun and trunnion, adding very greatly to the safety of the piece.

But such cutting away will not be necessary, for with such reduced weights as we shall make use of, and wheels so small as 3ft. 6in. height it will be quite unnecessary to give a 6 inch breadth of tire, I shall assume that $4\frac{1}{2}$ inches is considered sufficient, and as the breadth of base is measured over the tires, the adoption of a $4\frac{1}{2}$ instead of a 6 inch, gives us 3 inches more space between the wheels.

We have now got an axle so short as to be of immense strength and we may therefore dispense with the use of wood, The axle may be $3\frac{1}{2}$ inch square iron without its weight being too cumbrous and a bar 30 inches long $3\frac{1}{2}$ inches square, would stand 10 times as great a shock as any 32 Prs. could communicate. Yet it is so evidently better to err on the safe side that in my late construction I gave this dimension for a light 18 pdr.

We now come to consider the dimensions of the trail,—and it is in this part of our subject that the objections supposed to be made by B and C in my 4th paragraph must be attended to. To proceed as we have hitherto done, let us consider first, what are the circumstances which limit the question. Of course we desire to adopt the minimum size, compatible with efficiency, within what limits then may we proceed to diminish the bulk ?

And first its length—the shortest possible length is obviously the distance between the trunnions and base ring of the gun, and we have only to consider what forces us to use any greater length than this. The first consideration is that while the gun is laid horizontally the end of the trail must rest on the ground to support the breech. Thus the trail must be the hypothenuse of a right angled triangle, the other two sides being the gun and the elevating screw. But the angle formed by the trail and the ground must be sufficiently acute to ensure the trails having a free run over the surface

Digitized by Google

of the ground when urged by recoil, as if the angle were not sufficiently acute, the gun would in its recoil, dig the trail into the ground and rear up and fall over as we have all seen the old fashioned little 4⅕ inch mortars do !

Let us then ascertain what is the most obtuse angle found in practice to admit of the trails passing freely without digging, and fix that as the angle which the trail shall form with the ground. Prolong a line from the centre of the trunnions in the direction thus obtained until it reaches within about 4 inches of the ground then turn it and place your pintrail washer or limbering loop, or trail plate eye or whatever mode of hooking on the trail to the limber you may prefer. This will evidently be the minimum length.

The next point to be attended to is the depth and thickness of the trail cheek and then the form or pattern. The depth necessary to give sufficient strength, will of course depend upon the shock it will have to sustain, the weight it will have to carry, and this will depend in very great measure on the junction of the axle and trail. A gun has two motions, one on the trunnions as a centre, altering the angle the gun forms with the trail by the elevating screw or by quoins, the other on the axle as a centre, altering the angle the trail forms with the horizon, by resting it on the ground or on the pintrail hook of a limber. From not attending to the difference between these, has sprung that confusion of ideas which produces such objections as B and C are supposed to make in my 4th para: and we will now consider the effects of such shortening as I have proposed to effect in the heavy guns on each of those motions.

First the cutting away all or nearly all in front of the trunnions will very greatly increase the weight with which the breech presses on its trail, and therefore increase the difficulty of elevating or depressing.

This difficulty must be met by giving greater mechanical power to the elevating screw, if that be the mode employed for elevating, or by such increased mechanical facilities as will enable two men

Digitized by Google

to raise the breech from the trail with the same degree of ease as at present. So many modes of effecting either of these will at once occur to every Artillerist, that I shall not dwell on this part of the subject, but I must reiterate my caution to the reader to keep the facility, or otherwise, of elevating the breech from the trail quite distinct in his mind from all thought of the facility or otherwise of raising the trail from the ground.

We now come to consider the other motion a gun and carriage require, viz. a change of position, from the axle as a centre, to the ground or the limber hook; as may be required. Inseparably connected with this is the question of recoil, very little important to a land Artillery officer, but which (from the unfortunate arrangement by which all Naval Artillery questions are referred to the same body which decides all land Artillery matters and naturally desires uniformity) is allowed a most undue influence in deciding, on the size and weight of ordnance for all services.

Facility of limbering up and unlimbering is produced by precisely the same modifications of size, weight, &c. as produce greatly increased recoil, and in the precise proportion that you facilitate the manual operation, you will increase the violent flying back of the whole machine when fired. In the wooden construction now in use, the trunnions are nearly directly over the axle, and from the habit of seeing them so placed in all our gun and howitzer carriages, has sprung the idea that they are necessarily so placed—I will not presume that any of my readers entertain this erroneous idea, but on no other grounds could the objection of C in my 4th para: have been raised, and it has been raised.

Let us consider briefly where the junction of axle and trail should take place.

When the trunnions were so placed that the breech should only have a slight preponderance over the muzzle, that is, when they were only slightly in front of the centre of gravity of the gun, it was perfectly right to place them where the constructor did, but we shall lose sight of the principle on which he did so if we, having shifted the centre of gravity so much nearer the breech, retain

Digitized by Google

the relative placing of axle and trunnion. The old construction, as we have seen, compelled the adoption of an immensely heavy beam of timber, and all this being behind the axle contributed to give a very great weight to press against the ground, and both to check recoil, and render limbering up difficult; we propose to use a very light trail—the lightest possible consistent with strength, we shall therefore, if we wish to obtain the same resistance to recoil be obliged to place an equal degree of pressure behind the axle, incurring thereby the inconvenience of difficulty in limbering up equal to that now felt. This we can easily effect, by shifting the axles nearer to the muzzle, than the centre of gravity, if necessary placing it actually under the trunnions, when the whole weight of the piece or nearly so will operate in this manner; but this can never be necessary, it is as well however to point out that we have the power of so doing.

If we place the axle directly under the centre of gravity, of the gun, we shall find that the piece is exceedingly lively in recoil and that the heaviest 24 pdr. or 32 pdr. may be limbered up with the same ease as the present 3 pdr. It is therefore clear that between these two (placing the axle under the trunnion or under the centre of gravity) we get all varieties of stability to resist recoil, accompanied by precisely equivalent difficulty in limbering up. It is surely not unfair to assume that an arrangement by which the relative place of axle and trunnion may be so shifted as to ensure, at the will of the officer in charge of a Battery, any degree of steadiness, or if about to manœuvre in the Field any degree of handiness, *must* of necessity be superior to the present system by which we cannot change the relative place, however varied the services may be, required from a gun.

It occurs to me that some may doubt that the only check to recoil is the pressure of the end of the trail, but such doubts will be quickly removed if it be considered that the usual mode of putting the point, is, that a heavy gun recoils least—Why? Gravity can only impede recoil by its pressure on the earth, by the adhesion of the piece to the plane on which it stands, and this only takes place in.

Digitized by Google

3 points—viz. the point where the trail takes the ground and the lowest part of the circumference of the wheel.

But art has done so much, and is doing so much to annihilate all friction in the axle, so much pains are taken to ensure the perfectly easy rolling of the wheels that this portion of the resistance to recoil is nearly nugatory, it is the study of our lives to render it so, and we may fairly disregard the little obstacle it offers, and thus we find that the trail has the whole pressure, or rather that the pressure on the trail is the sole obstacle to recoil.

But to return—the limits within which such alteration of place of axle may be expected to be desired, do not extend (in such a gun of 5 ft. 2½ in. as I have above described) beyond about 12 inches it will be extremely easy to have 3 places in which the axle may be fastened, in my own construction I give only 2 and on trial they fully justified every prediction I had made, on the principles here explained. I have given a trail so long as 9ft. 9 inches, but I rather think I shall cut away a foot or 1½ ft. of this not for the great increase of strength which it will confer, for the carriage is now strong enough for a 32 pr. but to make it still lighter as altogether the carriage now weighs 14cwt. 2qrs. 14lbs. I have overlooked in constructing my carriage, one very important point, viz. that the 2 cheeks of the trail should be perfectly similar. Mine are bent in so as to approach very near at the end, but great advantage would arise from their being perfectly similar, and therefore running parallel to each other.

There are some minor points to be adverted to connected with the relative placing of axle and trail. The distance from trunnion to base ring being fixed we have no choice as to where the elevating screw transom, or quoin plate, shall be placed, but if we place the axle near the centre of gravity we lessen the distance from the axle, one point of suspension, to the elevating screw transom, the point where the force exerted to break the trail, acts. I need not shew that a beam suspended by its two ends on the axle and the ground, and subjected to blows on one point of its length, is stronger in proportion as the point of impact is near the point of suspension.

Digitized by Google

My own individual feeling on the subject of placing the axle is to have it so that the point of the trail, if placed in one scale of a balance, may be about held in equipoise by from 3 to 4 cwt. and if this gives too much recoil when fired with breaching charge, counteract the tendency by the construction of the platform, so shall your gun be handy for the field. For travelling long distances in peace times, the axle should be as far forward as possible to divide the weight between the gun and limber wheels.

Before concluding this subject we will advert to the effect so small a gun will have on the embrasures. First, from its being so very low (the lower line of metal is only 28 inches from the ground) there would be little or no fascine work at the bottom of the embrasure, unless indeed the platform were very considerably raised, in which case a corresponding height might be given to the lower face of the embrasure, but as this is a nearly useless portion of the battery, the disuse of it will not operate much to the disadvantage of my proposal. And with regard to the length of the gun which will project into the embrasure. I must beg my readers to compare my gun and carriage with the long gnn on its field carriage not on a ship or garrison carriage. On the latter the gun may go 4 ft. 8 in. or 56 inches into the embrasure, in the former only 30 inches and in mine only 6. The difference between the two latter of these, 24 inches is the portion of the embrasure which must be cut away so as to allow my gun to run close up to the parapet with the certainty that it will not injure the then embrasure more than the present gun does, for the muzzle will be at the same place as it now reaches to.

I have now noticed all the objections I can foresee, I will state the advantages to be derived from my proposal.

I shew that we shall obtain at once that reduction of windage which all have admitted to be necessary and which nearly a quarter of a century ago the Royal Artillery resolved on as a benefit to science, but which we see to be nearly as distant as ever from coming into practical use.

Digitized by Google

That concomitant with this we shall obtain such lightness of metal, without any sacrifice whatever of force or accuracy as shall enable our battering train to travel with the army and take its place in all general actions, allowing moreover so few cattle to the draught of each piece as to enable us with the same expenditure of animal power as at present to bring into use 3 times the present strength of battering trains. It is thus and thus only that we can hope to realize Sir John May's glorious idea of an Artillery attack.

I shew that all this is to be done with the guns at present in our Arsenals, and the shot now in store, any other mode of effecting the (admittedly necessary) alteration of windage, proceeding upon the supposition either of condemning the vast stores of shot now in hand, or of postponing till the latter part of next century, that benefit which might be enjoyed immediately.

By my plan a vast store of iron 9 pdr. guns and even iron 6 pdrs. of great length, and great weight, now in the various Arsenals would be at once transformed into the handiest 12 pounders possible. THE DUKE writing from Ahmudnuggur, 13th August 1803, says "You need not be in a hurry to bring up the 18 pounders, depend upon it that 12 pounder shot will breach any wall in this country." Now these 6 pounders and 9 pounders are totally useless, being in no way whatever preferable to the Brass Field Pieces, but they would make most valuable 12 pounders. Many of these are of 24 cwt. and 30 cwt. respectively, and have therefore quite sufficient metal.

I propose to make.

Of the present	Weighing	New	Weighing
24 pdrs.	48 cwt.	32 pdrs. about	34
18 „	42 „	24 „	30
12 „	34 „	18 „	$24\frac{1}{2}$
9 „	30 „	12 „	$21\frac{1}{2}$
6 „	24 „	„ „	$18\frac{1}{2}$

The carriage of a battering gun is now a most enormous weight and being made of the wrong material, every gun requires to have, besides the carriage on which it travels, spare carriages to accompany it, and of course 2 limbers.

Digitized by Google

The 18 pounder therefore has to draw it and bear it when fighting.

	Cwt.	Qrs.	lbs.	Cwt.	Qrs.	lbs.
2 carriages each	22	0	18	44	1	8
2 limbers each	15			30	0	0
Total				74	1	8
Its own weight is				42	0	0
Grand Total				116	1	8

Instead of which I propose to give a carriage made of such strength and durability as to be safe from all injury except the actual blow of round shot. This carriage shall be so constructed that a trail cheek destroyed can be immediately replaced by a few men in the field, and the cheeks of the trail being precisely similar, a shot will not disable the carriage but merely make it necessary to bring one spare cheek from the rear and change it. A single pair of these cheeks, a pair of wheels, an axle and a dozen of spare spokes (which may be put in by hand in 10 minutes) will be sufficient for a battery of 6 or 8 guns. We shall therefore have to draw

	Cwt.	Qrs.	lbs.
One carriage weighing.....	14	2	14
Limber.....	7	1	10
Total....	22		
Add share of spare carriage and its limber $\frac{3}{7}$	3		
Cwt.	25	0	16
Weight of gun	24	2	14
Total	49	3	2

Or a total of 50 cwt. not quite half the weight of the present gun and carriage, in fact only $\frac{43}{100}$ of the weight.

Instead of dragging a gun of 42 cwt. on a carriage and limber weighing 37. or nearly 4 tons weight with 38 bullocks in one team, I think we may fairly calculate that the gun and carriage with limber weighing all together 46 cwt.—will with equal ease travel with 14 or 16 Bullocks.

Digitized by Google

It must be borne in mind, that carrying 3 times the number of guns by no means implies that any larger quantity of shot will be carried. The same number of shot, doing the same work from more guns in less time, it is on the contrary not improbable that a reduction of shot may result from the greater rapidity with which a breach will be effected, or a column repulsed or annihilated.

The light iron carriages will it is said suffer more from shots striking them.—If so, it will be from a blow on the wheel, axle, or trail. The proceedings of the Committee at Woolwich which tried the wheel I propose to use, prove that the iron wheel suffers less from the effect of shot than the wooden, no one will suppose that a square bar of $3\frac{3}{4}$ thickness only 30 inches long, will not resist shot better than the huge and clumsy fabric on which the gun and trail now rest, which by offering 5 times as much surface will be likely to encounter 5 times as many blows, and being of a splintering material will scatter death around, while if the iron axle is struck it at least only carries 2 or 3 large fragments and will do less injury than the shower of splinters from the timber, and, lastly, if a trail be broken off the wooden carriage it is unserviceable till it has been sent to an Arsenal, in the iron carriage a key is knocked off at each end, a nut is unscrewed, a $2\frac{1}{2}$ cwt. beam of iron is brought up from the rear, and substituted in lieu of the broken one, and the fire recommences.

Instead of long ranges of gun sheds in which the gigantic structures now in use have a spacious quarter assigned to each of them a single room would hold, easily, a score of 18 pdr. guns and their carriages, the wheels lying in tall column, secured from decay by a little paint, safe alike from warping or swelling, from insect or dry rot, the axles in a heap by themselves the cheeks all precisely alike occupying scarcely any bulk, and the short strong gun the only thing requiring any mechanical assistance beyond the arms of two stout men, to carry it outside and put the whole together in 20 minutes.

Upon the principles above detailed, I had a 12 pounder cut short, reamed out and mounted on an iron carriage, which was

Digitized by Google

proved at Woolwich, and a few rounds fired from it, more full experiments shall be made as soon as the gun is landed in India. A short Memoir on the subject is printed in the Artillery Records, so that every Madras Artillery Officer will possess it, and I will send a copy to each Troop and Company of the Bengal and Bombay Regiments.

I shall feel much indebted to any Artillery (or other) Officer, who, not agreeing with me in the opinions I hold on these subjects, will favour me with his reasons, in writing, when I will either justify or abandon, conclusions which have led me into great expense, but which I believe to be calculated to produce great benefit to the Service, to which it is my boast to belong.

P. ANSTRUTHER, *Captain*,
Madras Artillery.

MADRAS, *December* 7, 1839.

REMARKS BY LIEUT. J. ASH, BOMBAY ARTILLERY, ON A PROPOSAL TO INCREASE THE STRENGTH OF THE INDIAN ARMY, BY CHANGING ALL THE GUNS FROM 18 PDRS. DOWNWARDS INTO OTHERS OF GREATER BORE, &c.

Audi Alteram Partem.

The necessity of diminishing the weight of our battering trains is most undoubted ; and any Officer who takes the trouble of entering into the details of a plan for so doing, is entitled to the highest praise. But there is so much distinctly marked difference in Artillery matters between *theory* and *practice*, that all such plans should be submitted to the severest scrutiny before any attempt is practically made to carry them into effect.

The idea of increasing the bore of each of our present heavy guns into that of the gun immediately above it, and then, still further decreasing their individual weight by cutting away a certain portion of their present length, appears at first sight, the most easy, cheap, effectual, and *immediate* method in which so radical a change in the weight of our present battering guns could be effected ; and the abolition of wooden carriages, and the substitution

Digitized by Google

of iron ones, is also a subject well worthy of the deepest attention of every Artillerist.

As this reduction of weight in the gun, and change of material in the carriage, are the immediate objects of Captain Anstruther's pamphlet, I shall bring forward such objections to his proposals, as occurred to me on an attentive perusual of his work.

In the first place Captain Anstruther (page 5*) states that, "we "owe our almost hopeless continuance in error to a habit which "all Artillerists, more or less, have permitted themselves to fall into, "of admitting extraneous considerations to influence their deci-"sions, on points which ought to have been kept quite clear."

Surely, it is not demanding too much from the inventor of a new piece of ordnance, to ask him in what his new gun is superior to the old one, or how several obvious objections may (or can) be overruled.—The *onus probandi* most distinctly lies with the inventor, and all reasonable objections should be explained away by him.—Thus should it be proposed by any one still further to lighten Captain A.'s gun by cutting off the trunnions. Should the method of fixing it on the carriage be called an "*extraneous consideration*," or should the proposer be called upon *to prove*, that without trunnions, the gun and carriage would retain their superior lightness, and still work equally well!

At page 6,† the author adverts to a few of these "*extraneous considerations*," and his manner of overruling some of them claims our attention.

"For instance, A. proposes a light gun, B. objects that it will "recoil too far.—It is quite clear that this is not an objection "to the *gun*, for the recoil is the retrograde motion of the *gun* "*and carriage*, the addition of weight therefore, or different "placing of the weight *may* alter the carriage so as to do away "with the objection." Now I ask, whether this mode of reasoning is the proper way of meeting B.'s objection? The *recoil*, says the author, is the retrograde motion of the *gun and carriage*,—granted—but unless these guns can be, and *are fired* without carriages, it is clear the gun *cannot* be considered apart from the carriage and that the consideration of recoil is not extraneous—

* Vide page 137. † Vide page 138.

Digitized by Google

He then goes on to tell us to increase the weight, or alter the construction of the carriage.—The first would evidently bring the gun and carriage up to the same weight as before the gun was cut down, and the latter is purely hypothetical; no proof of its efficacy being attempted. Therefore if recoiling too far *be a valid objection*, the author leaves it in full force.

The objection of C. is distinctly against the carriage, but still Captain Anstruther might point out to his readers, that changing the relative positions of the axle and trail would not interfere with the balance and general stability of the carriage; a good carriage being as equally indispensable as a good gun.

The objection made by D. is not worth much consideration; as these improvements are meant to be confined to India; but one of the methods of overruling E. is liable to the same remark as has just been made with regard to A. vizt. that it is not supported by proof.—The rigging *outside* of ships is intended to insure the stability of the *masts*, and the author ought by proof (or by quotations from good practical works) to have left no doubt on the reader's mind, that bringing the rigging inside could be done with safety. In short B. C. and E. can hardly be said, to have avoided the real question "light or heavy"—and surely but few will agree that they have made any attempt to *complicate* the question by the introduction of "extraneous circumstances."

At page 7,* Captain Anstruther lays down a rule on which he says, "his whole argument turns." This rule therefore is worthy of minute investigation.

It is a well known fact, that a short gun does not throw its shot so far as a long one, both being of equal calibres and at equal elevations.

Captain Anstruther lays it down as a rule, that the charge of the short gun should be increased until the range of its shot equals that of the long gun, and that this increase of charge can be made with perfect safety with the new guns which he proposes.

"Because effects are as their causes—until effects are equal "causes cannot be so, and the *shock* given to the breach may be

* Vide page 139.

Digitized by Google

" '*exactly*' estimated by the effect produced upon the shot. If " the short gun require 5 lbs. of powder to throw its shot as far at " equal elevation as the long gun did with 4 lbs. these two charges " of 5 lbs. and 4 lbs. *should be termed equal* as measured by their " effects on shot; and not their bulk or weight, they are equal " forces."*

Now so far from this rule or proposition appearing to me either clear or undeniable (vide p. 6.*) I consider it *inapplicable* to *practical* Artillery, unless one circumstance be granted which the very nature of our Artillery precludes, i. e. if you attempt to make the range of a *short* gun equal to that of a *long* gun, of equal calibre, and at equal elevations, by merely *increasing the charge*, both guns should be *immoveable*, for if this be not the case, the short gun with the *increased charge*, and *decreased weight* will recoil so far before this equality of force can be obtained, that it will be *practically* useless.

Now as we are reasoning solely on the effect of increased charges on guns fired on *wheeled carriages*, immoveability cannot be granted, and the rule with all its startling conclusions receives a severe shock from this circumstance alone.

But there is also another *fact* in practical gunnery which militates strongly against this " rule," vizt.

If a charge be used greater than that which will propel a ball 1360 feet in a second, a perfect vacuum is caused *behind* the ball, which brings the resistance of the air in *front* of the ball up to its maximum power, *and* " the† rate of the ball is" soon reduced to an ordinary celerity; now the initial velocity of a ball fired from a 24 pr. iron gun is 1339 feet per second‡ or in other words the pre-

* Vide page 140.

† Sir H. Douglas has these remarks on this subject (Naval Gunnery) After explaining that a body moving quick through the air, causes a kind of vacuum he proceeds as follows—When the Ball moves quicker than the air can rush into the *space* left behind,—the vacuum becomes complete, now there is a certain limit to the velocity with which air can rush into a vacuum, viz. about 13 or 1400 feet (by note at bottom of page 1360 when the barometer is at 30 inches) and consequently when the velocity of the ball is greater than this it is manifest that the resistance must be much increased. At page 130 therefore the following: *inference* is laid down—That there is a gradual and regular increase of resistance, as the velocity is increased; as far as the velocity of 1400 feet, when the vacuum behind the ball being complete the resistance is greatest.

‡ Sir H. Douglas's Naval Gunnery, P. 59.

Digitized by Google

sent charge for this battery gun is very nearly calculated to give that certain velocity to its shot beyond which it is of no practical advantage to go—and as the ratio between the weight of the gun and its shot is higher as the calibre diminishes (vide Table, page 9*) all those battery guns below a 24 pr. must be still nearer the mark. Therefore there is *every* probability that any serious increase to the charge, would only act, most injuriously on the recoil of the gun and would hardly increase the range of the shot at all, simply, because the dead weight (or power of resisting recoil) and the charge of the present guns are distinctly calculated for each other. Now if on these grounds it is proved that it would be useless to increase the charge of our present long and heavy guns, it is clear that these arguments are fully sufficient to deter many Artillerists from attempting to bring the range of a short gun up to that of a long one by merely increasing the charge.

In short, I am fully convinced, that there is but one practical method of increasing the range of a short (and consequently light) gun, which is *by increasing the elevation*, a measure which, *in any degree*, greatly detracts from its utility, and which if pushed too far would totally unfit it to act as a *breaching gun*.

Before dismissing this subject, however, I must remark the extraordinary circumstance that Captain Anstruther does not apply his own rule to his own gun—My readers may be surprised at my saying this; but still it is actually the case, and a few quotations from the work will, I think, establish the fact.

Let Nos. 1 and 2 be 18 prs. No. 1 the short gun, and No. 2 the long gun. At page 7,† Captain A. says "the officer in charge of "No. 1 increases his charge until he does obtain the same range "as the long gun" and then in the next paragraph hypothetically quotes the ratio of the new charge to the old as 5 to 4, or he gives his short gun 1 lb. more than the long one, therefore the new charge for the short 18 pr. would by this rule be about 7 lbs. or one lb. more than the service charge of the long 18 pr. On turning to page 12‡ the following passage meets the eye, "I only ask for the reamed up 12. 5 lbs. of powder and 18 lbs. of iron, and pledge my professional character on its equaling *any* 18 pr. in the service using 6 lbs. of powder and the same shot."

* Vide page 141. † Vide page 139. ‡ Vide page 144.

Digitized by Google

So that our author actually allows to the short and light new 18 pr. (made out of a reamed up 12 pr.) 1 lb. less charge than the heavy gun whose superior range it is to equal. In fact his new 18 pr. has only got 1 lb. more than the old 12 pr. from which it has been made (i. e. 4+1) instead of having at least 7 lbs. according to the rule laid down at page 7.* True it is, that he has reduced the windage, most materially; but *not* under the *impression* of thereby increasing the force of the smaller charge, (at least so it strikes me) but for the distinct purpose of making up for the reduction of length, i. e. he makes a rule of 3 sum thus. As the large windage is to the present length, so will the reduced windage be to the reduced length, a mode of procedure, from which I think no practical utility can be expected, because the ratio of the charge and recoil ought to be calculated *at the same time* or at least *allowed for*, as it is plain that a decrease of windage would increase the effect of the charge on the shot and on the recoil too.

The present calibre of an 18 pr. is inch 5·292, which is reduced in the new gun to 5·16, (the diameter of the shot being 5·06) now in my opinion such a great diminution in the windage would give to the 5 lb. charge an effect much greater than that of the 6 lb. charge with the old windage, and as Captain A. distinctly says that No. 1 is to *increase the charge*, I shall assume that the new gun has got a charge equal to 7 lbs. (i. e. 1 lb. *more* than the long 18 pr.) and direct the attention of my readers to the consideration of *dead weight* which in Captain Austruther's pamphlet is entirely omitted, his theory being apparently this. That if you can get a gun which will not *burst*, no diminution of weight will have the least detrimental effect on its useful qualities as a *battery gun*.

The theory of dead weight may be exemplified in a very easy manner.

Let us suppose a strong iron cylinder with a bore equal to that of an 18 pr. *open at both ends*, let us suppose that an 18 pr. cartridge is placed in the middle of the cylinder having an 18 pr. ball placed close at each end of it. On the charge being ignited it is evident that each ball would leave the cylinder with equal force, and would each range equally far, one to the front, and the other to the rear.

* Vide page 139.

Digitized by Google

If we now effectually close up one end of the cylinder and load with a cartridge and one ball, it is evident that the one ball will, (on the charge being fired) proceed to the front, and that the cylinder will proceed to the rear, the *range* of each being in the inverse ratio of their weights, i. e. the cylinder being the heaviest body would have the *least range*.*

Again if we go on increasing the weight of the cylinder itself (and also attach weights to it) it will be easy to reduce *its* range to a few feet, while the ball fired from it will have a range of 1 or 2000 yards, or in other words to obtain a very long range for the ball, the dead weight, or vis inertiæ of the gun and carriage *must* be some high multiple of the weight of the ball.

Let us now see what this high multiple is in practical gunnery.

Let us call the heavy cylinder an 18 pr. iron battering gun which weighs 42 cwt. the weight attached will be the carriage which weighs 22 cwt. both together will weigh 64 cwt. or 7168 lbs. which divided by 18 (the weight of the shot) gives 398, or (as we have left out odd quarters and pounds) about 400. Therefore actual experiment proves to us in this instance, that in order to reduce the range (or recoil, for it is the same thing) of this heavy cylinder and its carriage within reasonable limits they *are* made about 400 times heavier than the shot required to be projected.

Now this being more or less the case with *all battering guns*, there arise certain questions which must be answered in the most satisfactory manner before any body of Artillery officers would agree to have a single gun cut down, for it is almost impossible that such an apparently easy and cheap alteration could have been overlooked until now, had it been practicable.

In my opinion the first question to be asked, is not, whether we shall choose "*light or heavy*" guns, but is it practicably possible to make *a very light battering gun?*—The next question to be solved is this—Is not a certain quantity of *dead weight indispensible* in a gun, which is required to send its shot against a wall with

* The velocity of the gun in its recoil, and that of the ball, are inversely as their weights, sufficient allowance being made for friction—(Sir H. Douglas, p. 122).

Digitized by Google

sufficient momentum to produce a breach? And the next is consequently, have we arrived at the minimum practical quantity of dead weight absolutely required for a battering gun, or have we still to seek it?

In my opinion there are 3 *essentials* required in a battering gun, all of which imply great weight of metal, viz. A battering gun should 1st throw its shot with the greatest momentum. 2d, at the least possible angle, i. e. requiring the least possible elevation, and 3d, with very little recoil.

Theoretically therefore a battering gun should have an enormous quantity of dead weight, very little windage, and still less recoil.—Because such a gun would project its shot against the wall to be breached with the greatest possible momentum and in the straightest possible line—*Practically* we ought (as the breach is still to be effected) to retain all these qualifications, *as much as possible*, we therefore reduce the enormous weight as much as we consistently can, because we require to move the gun from place to place on a *wheeled* carriage, we increase the windage (or ought to do so) until we are certain that a long continued fire will not cause the gun to become too foul to receive its shot, and we prevent the recoil as *much as possible*, by *not making the gun too light*, that is to say, the weight of a battering gun should be for *practical* utility, a happy *mean* between what would be *too heavy for transport* and what would be *too light to make a breach.*

Now our present heavy guns throw a shot at nearly the greatest useful maximum velocity which can be given e. i. the maximum velocity is 1360 feet per second, and they throw at 1339, their elevations, at breaching ranges, are very small, and their recoil is not sufficient to run them off slightly sloped and very short platforms, or to interrupt the smartness of their fire on plain ground, more than can possibly be helped—And, so far from thinking that British Artillerists have continued in a hopeless state of error by admitting extraneous considerations, I am inclined to believe, that they have already done nearly all that can practically be effected to reduce the weight and length of battering guns to their minimum; and that they have only stopped at (or about) the point where from

Digitized by Google

sheer want of dead weight each description of ordnance would cease to retain the requisite properties of *battery guns.*

Thus in England we have no less than 7 kinds of 24 pr. iron guns, varying in length from 9 feet 6 inches to 6 feet, and in weight from 50 to 31 cwt.—Let us examine what is the consequence of *this* loss of weight and length, on this description of gun.

At page 104 of Sir Howard Douglas' work on naval gunnery we find the following passage. "Comparing the powers of the "*long* 24 pr. of 9½ feet with those of the short 24, length 6 feet "6, we perceive that altho' the extreme ranges may be nearly the "same, yet for PRACTICE at 300 yards the long gun might be "laid point blank, whilst the latter would require nearly half a "degree of elevation. At 1000 yards the former would only re-"quire an elevation of 2° which with the short gun would only "give a range of about 800 yards."

			feet	inches.
Now the long gun weighs	50 cwt.	and its length is..	9	6
short	33 cwt.		6	6
and their difference is	17 cwt.	and	3	0

Here then we have in the long gun an excellent piece of ordnance whose only fault is, that from its great weight it is difficult to transport, we reduce its length only 3 feet, and its weight only 17 cwt. and find that as a battering gun it has lost one-fifth of its useful qualities, i. e. it throws its shot in a ratio of 4 to 5. and requires its elevation to be increased, in order to make its ranges equal to those of the longer gun—now what is the line of conduct pursued by the English Artillerists? they make *one* still lighter gun of only 31 cwt. and 6 feet in length,* and there *stop*—and I think that few Artillery officers will be inclined to blame them for so doing.

There is also another principle which appears to have guided the English Artillerists, and to which I have already alluded in my

* Which is still available for many useful purposes, but which few Artillery Officers would acknowledge to be equal to *any* 24 pdr. in the service.

Digitized by Google

observations on the weight of battering ordnance, viz. that the weight of a gun should be a mean between what is too heavy for transport, and what is too light for breaching. Now it is evident that, if this rule has been acted upon, we ought to find that those guns which throw the smaller shot have a greater comparative quantity of dead weight than those which throw the larger shot.

An inspection of Table A, will shew clearly what I mean, and will also be very useful for other purposes. It is framed by simply reducing the weight of each piece of ordnance to pounds, and then dividing the amount by the weight of the shot.

From this Table we find that the 6 pr. heavy iron gun is 452 times heavier than its shot, while the 42 pr. is only 178 times heavier, and the reason of this is plain, for if the ratio of the 42 pr. were made equal to that of the 6 pr. it would weigh 18,984 lbs. or about 169½ cwt. and would be practically useless from its enormous weight. If on the other hand the 6 pr. were made on the ratio of the 42 pr. it would only weigh 1068 lbs. or about 9½ cwt. and would be useless, as a battery gun, from its extreme lightness. It is therefore evident that the 42 pr. *cannot* throw its shot with so much relative effect as the 6 pr. from sheer want of the same proportion of dead weight. But this mere reduction in its equivalent power is fully overbalanced by the still superior destructive effect of its heavy shot, and the actual superiority which it *would* have beyond what it *now* has, (were the gun heavier) is *voluntarily* given up in order that it may be transported and worked with ease.

There is another fact which is explained by this Table, viz. when a 24 pr. medium gun is fired with a service charge and one shot, the shock is so great that the carriage jumps off the ground to the height of 3 or 4 inches, which is so far from being the case with a 12 pr. medium gun that I have seen one used (during a practice) on a carriage *without cap squares*, as the superior ratio of dead weight was amply sufficient to keep the gun perfectly steady.

From this Table, also, we discover why the "great Robins" only proposed to ream up guns from the 18 pr. *downwards*, for if we look at the *great diminution* of dead weight which takes

Digitized by Google

place as the calibre increases, we shall have great reason to admire the caution which induced Robins to stop at the 18 prs.

Table B. will place these circumstances in a clear light. It is framed by calculating the weight of the portion of metal required to be reamed out of the 12, 18 and 24 prs., and by it we distinctly see, that when we ream up even the 12 and 18 prs. we shall not have *increased* the strength of the Indian army; but we shall only have obtained two new sets of medium and light 18 and 24 prs. which in every instance, but one, would be inferior to those now in use; from being lighter, and this would be at the expense of our two best descriptions of heavy guns, viz. the heavy 12 and 18 prs.

Having thus shewn that there is every reason to believe that a 12 pr. reamed up to the bore of an 18 pr. will prove inferior to the 18 pr. now in use, especially as a battering gun, from the diminution of its dead weight, we have to investigate Capt. Anstruther's startling proposal of still further reducing its weight by cutting off one-third of its present length. This we find at page 23* at once reduces its weight from 34 to 24 cwt. by which means tho' an enormous diminution of weight, is undoubtedly obtained, still the proposal is left open to many serious objections, amongst which however bursting need not appear, as the experiments mentioned in the pamphlet, are to me quite convincing that no danger need be apprehended on that score.

But in order to put my principal objection in a clear light, it must be borne in mind that Captain Anstruther proposes to reduce the weight of the carriage as much in proportion as he has that of the gun. To illustrate this in the fullest manner we will compare the weights of the present 18 pr. and carriage, with that of the proposed one as laid down in the pamphlet.

	cwt.				cwt.		
Heavy Iron 18 pdr.	42	0	00	Light 18 pr.....	27	0	00
Its Carriage.....	22	0	18	Its Carriage....	22	0	18
Total	64	0	18	Total	49	0	18

* Vide page 155.

Digitized by Google

The loss of weight therefore is only	15	cwt.		
Captain A's proposed gun.....	24	„	2	14
„ „ „ Iron Carriage..	14	„	2	14
Total	39	„	1	00

So that the loss of weight in this case would be 21 cwt. 3 qrs. 18 lbs. or within 10 lbs. of a ton and a quarter. And the proportion of dead weight to shot would be as follows:

Old gun and carriage 399 to 1. Proposed gun and carriage 2·4·4 to 1.

I have already remarked that Captain Anstruther does not appear to attach much importance to dead weight. The following passage from page 23,* will point out this clearly to my reader.

"By my plan a vast store of iron 9 pr. guns, and even iron 6 "pr. guns of great length and great weight, now in the various "arsenals, would be at once transformed into the handiest 12 prs. "possible. Now these 6 prs. and 9 prs. are totally useless, being "no way whatever preferable to the brass field pieces, but they "would make most valuable 12 prs. many of these are of 24 and "30 cwt respectively, and have therefore quite sufficient metal."

So that our author appears to be of opinion, that iron guns weighing respectively 30 and 24 cwt. with charges of $\frac{1}{7}$ of the weight of their shot, are to be considered as in *no way whatever* preferable to brass guns weighing only from 6 to 9 cwt. which are fired with charges of only $\frac{1}{4}$ of the weight of their shot. Now as I am a great advocate for heavy proportion of dead weight, and have already given my reasons for so being, I shall here quote a passage from Sir Howard Douglas' work (pp. 91 and 92) which appears to me to bear strongly on this point, as it notices the chief defects of under weighted guns. He is speaking of carronades, and says. "For it is a fact pretty well known, that although numerous accidents have occurred in action from the bursting of guns yet carronades, even double shotted have never been known to fail. They *break their breechings, draw their bolts, split their slides, but do not burst.*"

* Vide page 155.

Digitized by Google

Here we perceive the invariable concomitants of want of a sufficient dead weight, viz. an enormous increase of recoil and great damage to the carriage. Now let me ask if this is the case with light carronades whose common charge is only 1-12th of the weight of their shot, what will it be with the proposed cut down gun whose charge is to be above $\frac{1}{3}$ of the weight of its shot—I might also quote the 12 and 24 pr. brass howitzers, as another strong case in point; as I have seen them both *bend* and *break* their *iron axletrees* ss well as split the cheeks of their carriages to pieces.

In short, the consideration of *dead weight alone*, induces me to believe that to make a *very light breaching gun is as practically impossible*, as it would be to make a *light anvil* for heavy work, and further, that the light iron guns at present in use, are almost as near the minimum of dead weight which is absolutely requisite, as is consistent with their utility. And lastly, if guns are to be reamed up at all they should be only such as are the *heaviest* of each description, their windage should be less than that of our present guns, and a consequent reduction should be made in their charges, as by so doing we should obtain a new description of light iron guns which tho' inferior to the heavy ones, would still be most useful from their superior accuracy.

Now should other Artillery officers hold this opinion relative to the actual necessity of a very heavy allowance of dead weight for battering guns, it is easy to perceive how much their unwillingness to sanction the introduction of a very light battering gun into the service, would be increased when they find that the gun proposed for adoption would from the peculiar position of its trunnions (which are within a few inches of the muzzle) throw a weight of at least 23 cwt. on the elevating screw. To obviate the inconvenience which this would occasion, Captain Anstruther proposes giving a greater mechanical power to the elevating screw. A plan which I think from the very confined position in which elevating screws are, and must be placed, would be attended with the greatest difficulty.

Further, unless the position of the axletree can be changed so

Digitized by Google

as to bring it as near to the centre of gravity of the gun as it is in the present gun carriage, the difficulty of traversing the gun would be almost insuperable ; and even, were the traversing of the carriage thus facilitated a new series of difficulties would arise, which could only be duly appreciated by drawing one or two elevations of the gun and carriage from the measurements laid down in the pamphlet, and bearing in mind that the proposed carriage is of *wrought iron.*

On the Windage.

Before turning our attention to the carriage, I have a few remarks to make on the windage of these proposed guns, as I do not quite agree with Captain Anstruther in his method of treating the subject.

First then let us examine whether his statement of the *number* of deflections of a ball along the bore of a gun is fully borne out by facts.

At page 9* we find the following passage. " Now the shot in " its passage along the cylinder is acted upon by a constant force " and supposing any deflection from the perfect line of axis of " the cylinder, at the commencement of the shot's travelling, it " would describe a zigzag somewhat similar to the approaches " of a fortification, the *number* of these deflections will of course " depend upon the proportion between b. r. (the windage) and " b. o. (the bore.)

Now ; bearing in mind the usual angle given to a zigzag, I would ask, whether a ball moving at a velocity of about 1339 feet per *second*, in a true cylinder of only from ·17 to ·27 of an inch greater diameter than itself, can or does proceed in such a series of angles within a space of only 88 inches, or whether the angle of deflection of the ball, when leaving the gun, (to the right or left, above or below) can be like that of any known zigzag ?

Let us look to facts. A 24 pr. ball fired at a range of 300 yards or 900 feet will strike a target of 12 feet square almost every time. Now it follows; as the gun is pointed at the bull's eye, that the amount of deflection generally cannot exceed 6 or 7 feet in 900— which would make the angle of deflection at which the shot issues

* Vide page 141.

Digitized by Google

from the gun so extremely minute, is almost to prove, that the ball can only have touched the bore once, that is to say, the ball could not have made two deflections, at so minute an angle, and at so great a velocity within a space of only 88 inches, and further, that with a proper windage the amount of deflection would be hardly appreciable.

The windage for a battery gun depends on such plain and distinct rules that I should not have deemed it necessary to make a separate notice of it, had not our author laid down two somewhat unusual propositions, 1st, that the windage for *a carronade* should be fixed upon, as the one best suited for a battery gun ; and 2nd, that it *should be* so fixed upon without *any reference* to hot shot or any other consideration (p. 10*) At page 9† we find the following paragraph. " When the royal artillery select committee took the sub-" ject into consideration in 1817, they determined, for reasons never " published, that the windage for field guns should be ·1, and that " for garrison guns ·15, at least this was published as their decision " &c." and at page 10 we find as follows: " An Indian artillery " committee would now say " what is the minimum windage which " can be allowed." They would find that the 18 *pr. carronade* in " the Royal Artillery only allows ·04 to the high gauge, and ·09 to " the low, having a bore of 5-16, and this they would fix upon with-" out any reference to expansion at white heat or any other con-" sideration, perhaps 5-14 would be better &c."

Now I should think, that the " reason" for giving a battery gun a larger windage than a field gun, though never published, is simply this.

Powder when fired fouls a gun, therefore a battery gun whose charge is ¼d of the weight of its shot has been allowed a greater windage than a field gun whose carriage is only ¼th of the weight of its shot.

The French, who are not a people to allow themselves to continue helplessly in error, allow this principle, though they differ in the degree of windage, for they give ·133 to their battering guns, and ·088 to their field guns, and according to Sir H. Douglas, " The AMERICAN windage copies the French rather than ours." (p. 95.)

* Vide page 142. † Vide page 141.

Digitized by Google

Will any Artillery committee (on the principle of foulness *alone* agree with Captain Anstruther in bringing forward a *carronade windage*, as a proper *criterion** for that of a heavy gun, when the common charge for that piece of Ordnance is 1-12th of the weight of its shot, (the *highest* being $\frac{1}{8}$th and the lowest 1-16th.)

Again Sir H. Douglas says, (p. 76) " Now no degree of foulness " from quick firing, and no coat of rust that should be suffered to " remain, or can well remain on a shot is equal to ·07 (about 1-15th " of an inch, which a windage of ·14 would allow" (for this is the windage he proposed) but it would appear that when his proposals came before the select committee, it only reduced the windage of iron guns to ·15, and even that reduction has not been yet adopted.

I am not now contending for the proper windage for a battering gun, but I only wish to enter my protest against *any* windage being fixed on without taking into consideration *every* circumstance which ought to limit our decision on so important a point. Sir Howard Douglas in his excellent work on naval gunnery has specified 4 circumstances which should be borne in mind when the amount of windage is under consideration, vizt. heat, rust, foulness, and tin straps, and I am of opinion, that a 5th might be safely added, vizt. the want of *perfect* sphericality in most round shot, which from being made of refuse or very inferior iron, hardly ever preserve their true figure in cooling. This consideration is allowed to be of importance by Sir Howard himself, who in his notice on shot gauges at page 76, says, " with ring gauges, shot not perfectly " spherical may pass in one direction or section, but not in all. " Shot gauges should therefore be cylindrical as in the French " service ; for balls which roll freely through *guage tubes* cannot " possibly jam in the cylinder of the piece, if it be perfect."

With these extracts before us, let us see how the case stands with the proposed gun.—Sir Howard Douglas proposed to reduce the windage of heavy guns to ·14 of an inch, but the select committee, after mature of deliberation and actual practice fixed it at ·15 of an inch. Captain Anstruther proposes to give his new reamed up 18 pr. a calibre of only 5-16 to project shot of 5-12 in.

* I. e. The windage *proper* for a carronade, would not be the proper windage for a siege gun, and if the *present* windage of a carronade is sufficient for a siege gun; it is too large for a carronade.

Digitized by Google

(high), and 5-07 in. (low) which would give a windage of either ·04 or ·09 and then says, that perhaps 5-14 would be better; thus leaving a windage of only ·02 or ·07 which appears an extraordinary windage for a set of guns whose foulness, and the rust of their shot, are represented as amounting to nearly ·07, and this is proposed as the windage for a battering gun whose charge, at page 7,* is *increased* to 7 lbs. and which is fairly *set down* at page 12,† as 5 lbs. both of which ratio of charges are contrary to the generally acknowledged rules for reduced windage, as we find that Sir H. Douglas proposed to reduce the charge 1-6th even with a windage of ·14.

Is it probable that any Indian Artillery committee would agree to such a reduction of windage as this? or that they would sanction such a service charge as *either* of those just mentioned, to a gun which had lost nearly $1\frac{1}{4}$ *ton* of its *dead weight* and had its windage reduced to ·02 or ·07?

On the Carriages.

We have now to consider the practical utility of wrought *iron* carriages.

As our present wooden carriages are undeniably open to many objections, the grand question, whether any other material can be applied to their construction, is one of the highest importance—few I imagine, would vote for wooden carriages (especially in India) if there were any better material wherewith to construct them. —Captain Anstruther proposes *wrought iron*, and we have to consider, 1st, whether as a material, wrought iron *is* in *every respect* better than wood for the construction of carriages for *battering guns*, or if not, whether the disadvantages which can fairly be urged against it will, or will not counterbalance the advantages which may be practically expected from its adoption?

Wrought Iron as a Material.

At first sight it would appear, that *iron* being stronger than wood, is a much fitter material wherewith to coustruct our gun carriages, but let us examine a little in what the strength of iron consists (for strength is only a relative term.)

The strength of wrought iron is occasioned by its *density* and *enormous tenacity*, but still iron is totally useless on some occasions; because its ductility renders it liable to *bend*, though from

* Vide page 139. † Vide page 144.

Digitized by Google

its tenacity it is almost impossible to *break* it. For example, a rod of iron, say 1 inch square, and 12 feet long, used as a tie-beam to a truss, would, from its enormous tenacity bear up almost any possible weight of roof &c. But take this very rod, out of the truss, and attempt to use it as a lever of the 2d order, i. e. (the weight between the power and the prop) by placing props under its two extremities, and it would not bear its own weight without *bending*.

In fact while its tenacity is enormous, it has little or no elasticity especially in large pieces; wood on the other hand in large pieces is highly elastic and will regain its original form after any violent stress or strain has been applied to it, *provided* that the strain be not sufficient to break it.

Now let us apply these observations to a gun carriage considered simply as a *support* to a gun.

The cheek of a gun carriage is a lever of the 2d order, i. e. the weight of the breech of the gun is between the extremities. A *square* rod of either wood or iron would not be suitable for this purpose, and I should give *depth* to either, *but not for the same reason.* I give depth to the iron cheek in order that the weight of the gun's breech may not *bend* it, and I give depth to the wooden cheek in order that the weight may not *break* it, and the depth of each would be regulated by their just mentioned properties.

Let us now examine how the case stands when we come to fire the gun.

On firing a battering gun which is at all deficient in *dead weight*, the gun and carriage jumps entirely off the ground, and descend again *most heavily*, and a smart, sharp, and very heavy blow is given on the elevating screw transom, by the breech of the gun and these two enormous shocks (if the gun were engaged in breeching) would be repeated between 20 and 30 times an hour from sunrise to sun-set, and perhaps at night besides. Now if I employ wood in the construction, I know that I must so far increase the breadth, depth and length of the cheeks (and other parts proportionably, that a very heavy carriage is the inevitable result, it cannot be helped,* but still there is a *limit* to the weight, because when I have found the

* In my opinion no attempt ought to be made to avoid having a heavy carriage for a heavy gun, as it forms part of the dead weight which as being absolutely necessary ought not to be reduced.

Digitized by Google

dimensions which *will* stand these continued shocks, without breaking, or splitting, I can stop.

Let us now turn to *iron* as a material. We have already shewn that as iron owes its strength almost entirely to its density and tenacity, it is singularly unfit in the form of a bar to support a weight placed between its extremities—because it will *bend*, but when instead of *only* having to bear up a weight, it is also exposed to reiterated, smart, sharp, and very heavy blows, which are constantly repeated on exactly the *same spot*, and that spot almost the weakest part of the cheek—we perceive at once that it is one of the worst materials which could be used—*simply from its want of elasticity*, the *only* thing to be done therefore is, to increase its depth and breadth, and to diminish its length as much as possible.

Therefore the following questions may be safely put to all those who propose wrought iron carriages:

1st. Can a pair of wrought iron cheeks be constructed which *will not gradually bend*, under the repeated heavy shocks, incident to a battering gun-carriage when in action and still be no heavier than the wooden carriage now in use which does stand them?—and secondly, would it be possible to make such wrought iron cheeks *considerably lighter* than the wooden ones now in use, without any chance of their bending, or detriment to the power of the gun? Lastly, in order to bring our questions to bear particularly, on the subject before us. Is the limit of weight due to this consideration known, and does it fall within what is required for the construction of a carriage for an 18 pr. only weighing 14 cwt. 2 qrs. 14 lbs. instead of 22 cwt. 0 qrs. 18 lbs. as proposed by Captain Anstruther?

As the case stands at present, much doubt may be expressed as to whether this last question *can* be answered satisfactorily (tho' I sincerely hope it may) and in my opinion if it cannot—the known tendency of wrought iron to *bend*, forms a *fatal-objection* to its being used as a material for *light* gun-carriages.

But if want of necessary dead weight, and liability to bend, were not obstacles of sufficient weight to induce a committee to reject the adoption of such a carriage, Captain Anstruther presents us with a gun of $5\frac{1}{2}$ feet in length (p. 12.*) which has its trunnions *only a few inches* from its *muzzle*—whereby it is entirely deprived

* Vide page 144.

Digitized by Google

of that *balance*, which in other guns, materially lightens the blow on the elevating screw transom, and renders them easy to elevate, limber up, and traverse.

As I have never seen a wrought iron carriage, I should be inclined to propose my objections with the greatest deference to Captain Anstruther's opinions; had he given us more practical information regarding the one he has constructed. (Thus a plan and elevation of the carriage, its cost, a few quotations from practice, tables of range and elevations, state of the carriage after heavy firing, its actual recoil, appearance of a carriage after being struck by shot, or detail of damages accrued would form but a small part of the information eagerly sought for by all those who are interested in an improvement of such apparent magnitude).

But as he proposes a simple theoretical question, it is at the option of every one to investigate its probable utility if it were reduced to practice.

His question is, "how shall we construct of wrought iron the *lightest carriages* of sufficient strength for the use of cannon?" He says, the solution is "easy," we shall see.

Let us look to our data.

Given—A 12 pr. iron gun reamed up to an 18 pr. bore, but with a windage of only, ·04 or, ·09 (or perhaps of only, ·02 or, ·07) and cut down so that the trunnions are within a few inches of the muzzle—with a charge equal (either way) to more than 6 lbs. of powder—length, 5 feet 2½ and weight only 24½ cwt.

Required—To place the same on a wrought iron carriage weighing only 14½ cwt. (instead of 22 cwt.) so as to make it equal "any 18 pr. in the service" i. e. it will throw its shot as far, with as great momentum, and at as low angles of elevation—will recoil as little—and can be *pointed*, *traversed*, and *limbered* up with equal facility.

Without plans and elevations it is evidently useless to proceed to details. Any Artillery officer who will take the trouble to measure a 12 pr. gun, and construct a carriage for it by the dimensions laid down in the pamphlet, will be enabled to draw 3 elevations*

* 3 Are required as there are 3 positions in which the axletree may be placed, 1 under the trunnions, 1 under the centre of gravity, and 1 between these *two points*.

Digitized by Google

with sufficient correctness, greatly to assist his judgment on the merits of the proposed carriage, and I would only request him, when so employed, to bear in mind the following circumstances, and then ask himself whether the solution of this question is so easy as it is represented.

The lightest English 18 pr. and carriage weighs only 15 cwt. less than the heaviest 18 pr. and carriage.

The proportion of dead weight in the heavy English 18 pr. is 7186 lbs. to 18 or 399 to 1.

When Sir H. Douglas proposed to reduce the windage of 18 pr. from ·25 to ·14 *he also proposed reducing the service charge* 1-6th.

The centre of gravity in English iron guns is near the trunnions.

The Woolwich select committee of 1839 state "It has already been ascertained, that "wrought iron carriages are *totally destroyed at once* by shot "striking them" i. e. if one part is struck by a shot the shock is so great, as to ensure the destruction of the rest of the carriage.

The present light 18 prs. are *confessedly inferior* to the heavy ones.

The proposed gun and carriage is 24 cwt. 3 qrs. 18 lbs. or a *ton and a quarter* lighter

The proportion of dead weight in the proposed gun and carriage is only 4396 to 18, or 244 to 1, what would be its recoil?

Captain A. reduces the windage from ·25 to ·02 or ·09, and tells us, that we must *increase* the charge, in order that the short gun may send its shot as far as the long one.

The proposed gun has its trunnions within a few inches of the muzzle, thus bringing a weight of nearly 23 cwt. on the elevating screw, and its transom.

Captain A. informs us at page 25,* that "if a *trail be broken off* his iron carriage, a key is knocked off at each end, a nut is unscrewed, a 2½ cwt. beam of iron is brought up from the rear and substituted in lieu of the broken one, and the fire recommences!

Would the proposed gun and carriage, be equal to *any* 18 pr. in the service? vide p. 9.

With these observations I shall bid my reader farewell.

These remarks have been thrown together under the impression that on all subjects connected with so expensive a branch as the Artillery undoubtedly is, both sides of the question should be minutely examined; and no proposal should be adopted, until every fair, and legitimate objection has been pointed out and overruled.

JAMES ASH,
Bombay Artillery.

* Vide page 157.

Digitized by Google

TABLE A.

Table of the dead weight of the undermentioned Iron Ordnance shewing the ratio between the weight of each Gun and its shot in lbs.

Nature of Ordnance.						Heavy.			Light.		
42 Pounder	9	feet ...	...	..	1 kind...	178	to	1			
32 ditto	from 9½	feet to 8	feet	..	2 kinds..	194	to	1	174	to	1
24 ditto	from 9½	feet to 6	feet	..	7 kinds..	233	to	1	144	to	1
18 ditto	from 9	feet to 6	feet	..	3 kinds..	261	to	1	168	to	1
12 ditto	from 9	feet to 7½	feet	..	3 kinds..	317	to	1	270	to	1
9 ditto	from 9	feet to 7	feet	..	5 kinds..	385	to	1	311	to	1
6 ditto	from 8½	feet to 6	feet	..	6 kinds..	452	to	1	300	to	1

TABLE B.

Shewing difference in weight between Reamed up and Old pattern Guns.

	Length	Weight.		Old Pattern. Length.		Weight.		Loss	
	feet.	cwt.	qrs.	feet	inch.	cwt.	qrs.	cwt.	
New 32 prs. or	9½	48	0	9	6	55	2	7½	
Reamed up 24 Prs.	8	46	2	8	0	49	3	3¼	
New 24 Prs. or	9½	none	0	9	6	50	0	0	
Reamed up 18 Prs.	9	40	3	9	0	47	2	6¾	
	8	35	2	8	0	43	2	8	
	6	26	1	6	0	31	0	4¾	
New 18 Prs. or	9	32	2	9	0	42	0	9½	
Reamed up 12 Prs.	8½	31	3	8	0	37	2	5¾	Gains 1 foot in length and 1 cwt. 1 qr. in weight
	7	28	1	6	0	27	0	0	

Then by taking the weight of the Heaviest gun of each calibre, we can compare the loss in cwt. between the old medium and light and the proposed reamed up gun.

Medium and Light.

Thus a Heavy 32 Pr. weight 55½ cwt. *Old pattern, loss.* 5¾ ... Cwt.
Reamed 24 Pr. loss. 7½ & 9 Cwt.

„ „ 24 Pr. „ 50 cwt. *Old pattern, loss* 2½6¼ 10½ 17½19 Cwt.
Reamed 18 Pr. loss. 9¼ 11½ 2¾ Cw.

„ „ 18 Pr. „ 42 cwt. *Old pattern loss.* 4½ and 15 Cwtt
Reamed 12 *Pr. loss* 9½ 10¾ & 13¾ Cwt.

Digitized by Google

LOSS IN NAVAL ACTIONS.

The naval actions of the English have been always remarkable for the comparatively small loss of life with which they have been gained; and in the estimation of the country, this has always formed a principal feature of the public triumph.

In Lord Howe's action of the 1st of June 1793, they were twenty-six sail of the line engaged, with 17,000 men. The total of the killed and wounded amounted to 1078.

In Lord Bridport's action of the 23d of June 1795, there were fourteen sail of the line, with 10,000 men. The killed and wounded were 144.

In Lord St. Vincent's action there were fifteen sail of the line, with 10,000 men. The killed and wounded were 300.

In Lord Duncan's action, October, 1797, there were sixteen sail; (including two 50's,) with 8,000 men. The killed and wounded were 751.

In Lord Nelson's battle of the Nile, 1st August 1798, there were fourteen sail, with 8000 men. The killed and wounded were 895.

In Lord Nelson's attack on Copenhagen, 2d of April 1801, there were eleven sail of the line and five frigates, with 7000 men. The killed and wounded were 875.

In Lord Nelson's battle of Trafalgar, 21st of October 1805, there were twenty-seven sail, with 17,000 men. The killed and wounded were 1524.

In Lord Exmouth's attack on Algiers there were five sail of the line and five frigates, with 5000 men. The killed and wounded were 818.

The difference of losses in those engagements is to be accounted for in general by the circumstances of the conflicts. But the attack on the Algerine batteries inflicted the severest loss of the whole, in proportion to the number engaged—it was a little less than a fifth. The action at Acre cost least of all; and the value of this distinction is overbalanced by the fact, that it evidently arose, not from accident, but from increased skill. The precision to which the British gun practice has been brought within the last few years, was here tried for the first time in reality,

Digitized by Google

and its effects were to drive the enemy from their defences almost in the very commencement of the battle. The daring with which the ships were brought up within scarcely more than pistol shot of the walls, had been often equalled by the British; but the coolness, steadiness, and precision with which those enormous guns were worked, is described as a new feature in naval war. The fire from the Admiral's ship is said to have amounted to eighty broadsides, poured in at the rate of one every two minutes, and the fire of the Commodore's ship, the *Powerful*, was scarcely less than volcanic.

REGULATIONS TO BE OBSERVED RELATIVE TO THE RECEIPT AND EXAMINATION OF STORES AT THE SEVERAL PRESIDENCIES IN INDIA; UNDER THE AUTHORITY OF THE COURT OF DIRECTORS.

1. The Stores are to be examined immediately on their being landed, in the presence of a Committee of Officers on behalf of the Company; and as the Ship-owners are only liable for the damages or short delivery of goods when the packages are delivered in a defective state, the persons on the survey should be directed to pay every attention to the condition of the several packages, and to Report particularly the state in which they were received, and the causes which, in their opinion, appear to have led to the injury or deficiency.

2 Those packages which shall have been marked on their first receipt from the ship as in a defective state, should be immediately opened (due notice having been first given to the Captain to attend, or to depute some person to do so on his behalf); and the columns of the printed form of report accompanying these Regulations filled up, and signed by the persons attending the survey, with elucidatory remarks, wherever damage or short delivery may appear.

3. Every possible exertion should be used that all the other packages, though apparently in good condition, should be opened in the presence of the gentlemen on the survey, previous to the departure of the ship; and the whole of the stores should be

Digitized by Google

examined, and the damages and deficiencies reported to Government, in order that the amount of any such damage, &c. for which the Ship is liable, may be deducted from the freight due, in conformity to the undermentioned clause in the conditions annexed to the tender for freight.

" 12th. That the freight, with primage and average accustomed, be payable as follows, viz. one-third in England fourteen days after final departure, and the remaining two-thirds in India on delivery of the goods, according to the tenour of the Bill of Lading at the rate of exchange mentioned in the Company's Advertisement. In both instances the freight is to be subject to deduction of the charges or penalties which may arise by a breach of agreement; and that portion payable in India to the deduction of such amount as may be fixed by the proper authorities in India, for any damage or deficiency of the goods to which the Owners may be liable according to the conditions of the Bill of Lading."

4. Each package should be inspected before opening; and if broken, or the nails appear to have been drawn, the same should be noticed in the Report, provided there appears short delivery or damage.

5. Where short delivery or surplus articles appear in any package, they shall be twice counted, and such surplus and short delivery should be noted.

6. As it would occasion great delay to count flints which cannot be injured by salt water, they may be taken by weight, without opening the packages.

7. Grape shot, and all articles now taken by weight will continue to be so.

8. All articles not inclosed in packages are supposed to be counted or weighed by the Captain of the vessel on shipment, and consequently any loss is chargeable to the Owners. This is particularly to be attended to in bars of iron, which may be changed or mixed on ship-board.

9. If any package or loose article, not described in the Invoice, is received, particulars thereof should be given and marked

Digitized by Google

as surplus. If belonging to another Presidency, intimation should immediately be sent to such Presidency.

10. Should any articles of store appear to the Committee of Survey to have original defects, which with every vigilance on the part of our Inspectors may occasionally happen, they are to be returned to Europe, that the subject may be investigated, unless they are of so bulky a nature as to make freight an object, in which case a portion only, taken promiscuously from the whole, is to be forwarded.

11. To avoid unnecessary trouble, it is not considered requisite for the Committee of Survey to notice in their remarks, any damage of so slight a nature as not to admit of a charge being made for the amount.

REPORT OF CAPTAIN COGHLAN, BOMBAY ARTILLERY, ON THE ARTILLERY EQUIPMENTS AND ESTABLISHMENTS DURING THE WAR IN AFFGHANISTAN, TO THE SECRETARY TO THE MILITARY BOARD, DATED 15TH APRIL 1840.

I am honored by the receipt of your letter of the 13th instant No. 1040, with accompaniments on the subject of the experience gained during the late campaign into Affghanistan in regard to our Artillery equipments and establishments.

It would afford me a high gratification were I able to submit to the Board, satisfactory and conclusive evidence on such important points; but I regret to say I am provided with few written memoranda bearing upon them, the duties of my office with the army left me little leisure for writing, and I am therefore unable to give more than general answers to most of the questions, however, the circumstances of the whole service are so recent and so fresh on my memory, that I apprehend no difficulty in recalling the general results of my observations, though in the absence of written notes of my own, it would be satisfactory to me, and to the Board, to give a reference in particular cases, to parties who from their situations, opportunities, or habits, may be qualified to correct any errors into which I may fall.

Digitized by Google

I shall divide the report into the following heads. Field Carriages —Pintail eyes—Wheels—Poles & Shafts—single and double driving—Store & Forge Carriage—Spare Carriages—Carriage for Troop Stores—Mode of conveying spare Gun Ammunition,—Arms for Foot Artillery—Horses for Artillery generally—Horses for Foot Artillery—Bullocks—Camels for Artillery draft—best draft for Field Guns.

Field Carriages.—Those in use with the Bombay Brigade were all of the " contracted trail" pattern introduced by the late Major Miller 1825-26, and similar to the Madras Carriage constructed about the same time by Lieut. Colonel Cullen; the wheels were of the Madras pattern, with cast iron naves.

As the new carriage constructed under the direction of the Select Board of Artillery Officers from the three Presidencies, has been introduced, it will not be necessary to describe at length the faults of the carriage, which has now become obsolete, it will be sufficient to say of it, that no confidence could be placed in it; the howitzer carriages in particular, altho' new when the Army of the Indus was formed, were absolutely worthless; the 24 pdr. howitzer carriages had been subjected to, and stood the usual proof on being turned off the Manufactory at Bombay, and after performing the march to Ghuznee, went thro' the action of the 21st July, using service charges at 6 or 700 yards without exhibiting any flaw, yet these same carriages were used at point blank ranges on the 23d July, all gave way more or less, two of them were so completely broken that the howitzers were dismounted.

A 6 pdr. carriage also broke down in like manner, these failures were the more remarkable from the fact, that no such accidents occurred to the carriages of the Bengal Artillery, who were engaged with us, and used the old block trail pattern.

On the return of the Bombay Troops, two 12 pdr. howitzers were sent with a Detachment to Khelat, 24 pdr. howitzers would have been preferred, but their carriages could not be relied on, accordingly the two best 12 pdr. howitzer carriages in the Brigade were selected, two of which had stood on the two days on which we were engaged at Ghuznee, these performed the work re-

Digitized by Google

quired of them in action at Khelat, but were both sprung by it and rendered unserviceable, though they had not altogether an hour's firing.

Here again the superiority of the Bengal carriage was shewn, for four 6 pdrs. in the service of the Shah received no injury whatever, the fractures in each of our carriages occurred at the same point, viz. down the cheek, commencing just behind the elevating screw transom.

As the field carriage constructed for general use at the three Presidencies, is of the same *principle* as those which have been found so faulty, it may not be out of place to record an expedient adopted by Lieut. John Jacob, for the repair of a 24 pdr. howitzer carriage, which had in its first round split both cheeks within one and a half inches of their entire depth ; each broken cheek was strengthened by an iron plate below, from the front part over the axletree and continued to within a foot or two of the trail end ; a similar plate was laid on the upper part of the cheek, and the two bolted together at intervals of a foot and a half ; this repair was made in the roughest manner, and I believe principally by Lieutenant Jacob's own hands, for the accident occurred on service at a place where little aid could be got, and the case was one of emergency ; however the broken carriage thus repaired, stood the following extraordinary trial, charge 2½ lbs, elevation 19° range 3000 yards (the howitzer used being of the light kind, General Miller's 8 cwt. 3 qrs.) and it subsequently stood other trials without giving way in the slightest degree, the cheeks thus strengthened are not unlike those made a century ago by Muller, and very similar to some which we find in the service of Native powers in India.

But it appears to me that Teak wood carriages whatever may be their construction, cannot be relied on ; nor would any previous proof satisfy my mind as to their stability, for I have known them stand a heavy proof without failing, and then break down in the first few rounds of a subsequent, though less severe trial,—for example, a 24 pdr. howitzer carriage was proved on the beach in Bombay (with a light howitzer 8¾ cwt.) service charge, and 24 pdr. *shot*, 50 rounds at 3 elevations P. B.—7½° and 15°, the trail

Digitized by Google

being sunk in the sand to stop the recoil, under this severe trial, the carriage exhibited no flaw, it was sent to Calcutta, and there broke down in the 1st experiment, the particulars of which I do not now remember, but it was not so severe a trial as that which I have described, and which I witnessed; other two instances I have given in the failure of the 24 pdr. howitzer carriages on the 2d day at Ghuznee, and of the 12 pdr. howitzer carriages at Khelat.

The distrust which I have of Teak wood for gun carriages, will plead my excuse for here introducing an accompaniment marked F, sketch* and description of a proposed 24 pdr. howitzer carriage by Lieutenant Ash of the Artillery, an Officer who has given much attention to this subject.

Ammunition Waggon.—Our Ammunition waggons have two great defects, they are very top heavy, and the perch constantly snaps asunder, from jerks and wrenches on bad roads; or breaks away from its fastenings to the axletree, this last accident we found it necessary to guard against by additional bolts, passing through the perch and centre beam of the platform, but though this expedient which was the best our circumstances allowed, succeeded tolerably well, the real remedy would be to employ a tougher wood than Teak for perches, and if instead of bolting the end to clamps on the axletree bed, an iron tennon was made to rest on the upper surface of the iron axle, our present perch (in construction) would be preferable to the Bengal pattern, which is to be introduced with our new carriages, and for this reason, the Bengal perch passing over the axletree bed, along the entire length of the platform, cannot be removed and replaced without unshifting the boxes and taking the frame to pieces, while ours can be easily shifted on the march.

It is true the Bengal Artillery did not make any objection to their perches, but then they never broke them as we did ours, for theirs were of superior wood, and larger scantling, and their waggons being much broader between the wheels than ours, they were seldom upset, and their perches were much less wrenched, but it is always proper to employ the best construction, whatever the material may be, instead of remedying one defect by another,

* Sketch not given.

Digitized by Google

which we should be doing were we to increase the span of our wheels and thus gain stability at the expence of increased draft and difficulty of driving.

The Bengal carriages owing to their width could not have gone along the narrow parts of the Linker pass, without detaining the Army perhaps several days to widen the path, which was in many places a scarped rock, nor could they cross bridges, or go through streets with the same facility as ours.

The difference in draft too with wider span of wheels, was so considerable in the case of one of the 24 pdr. howitzer ammunition waggons, which was a few inches wider than the rest, that the Officers of the battery could not fail remarking it daily, forty-four (44) inches from shoulder to shoulder has been fixed by the Committee of Artillery Officers assembled at Calcutta, a width quite sufficient, any tendency to top heaviness may be removed by a very simple contrivance, which has been suggested to me by Lieut. Gainsford, viz. by constructing the waggon body so as to admit of the boxes being let down about 6 inches in the frame of the platform, which would bring the shot so far down as to materially lower the centre of gravity, and yet be high enough to preserve the shells from injury in crossing water, for when deep enough to wet them, it would be too deep for the team to draw the waggon with the boxes on.

Pintail Eye.—The question as to whether the pintail eye of gun carriage trails, and waggon perches should be "fixed" or "swivelled" has I am aware been much discussed, I am of an opinion, that the eye should be on a swivel, the fixed one being extremely dangerous to the wheel driver and his horses in case of an upset, to say nothing of the delay and trouble in righting the limber, if the gun should (as is probable) overturn it also, whereas the gun or a waggon body if upset alone is righted in a few minutes, and the overthrow exposes no one to danger.

Wheels.—The Madras pattern wheels stood as well as could be expected when it is considered that they are entirely of Teak, a wood which shrinks so much that the wheels constantly require tightening, and occasionally retiring. Bendy and Bawbel might

Digitized by Google

I think be used with gr eat advantage in our gun wheels, retaining the present construction.

The Bengal Artillery wheel of the old pattern with wooden nave, appeared to require fewer repairs than ours, but that might probably be attributable to the superior wood of which it was made.

Poles and Shafts.—The relative merits of poles and shafts for Artillery draft, were very keenly discussed between the Bombay and Bengal Artillery Officers with the Army, the latter were without exception all in favor of the pole system, which had obtained at their Presidency since Horse Artillery was raised there; the question was however brought to issue by the Bengal and Bombay Artillery marching together from Kandahar to Ghuznee, and thence to Cabul, during this march the superiority of the shafts was repeatedly shewn, the most experienced Officers of the Bengal Artillery Brigade, who had been amongst the strongest advocates for the pole, became converts to the advantages of the shafts.—Before leaving Cabul, and separating from the Bengal Artillery, the three senior Officers, Major Pew, Captain Abbott, and Captain Grant of that arm were requested to state in writing, the result of their observations and experience on this point, of their replies to my address, I have only a copy of one (Captain Grant's) the others are in the possession of the Commandant of Artillery; they would form an interesting accompaniment to whatever information the Military Board may wish to supply on this subject; in furtherance of this object, I annex copies of letters marked A. B. C. D. E.

Single and double Driving.—The Board is aware that the Bengal Horse Artillery system of driving, differs from that practised by the Royal, by the Madras, and by the Bombay Horse Artillery, viz. carrying a driver on each of the off horses, as well as on the near ones, this particularly has been discussed amply in the Special Board assembled in Calcutta, it will therefore be sufficient for me to say, that the experiences of the late Campaign has confirmed the Bombay Officers in their opinion, of the superiority of

Digitized by Google

the single system, and if my memory be correct, I think one or two of the Officers named in the preceding paragraph, expressed in the letters referred to, their opinion that our system of driving a pair of horses, English fashion by one man, was superior to theirs, of mounting a driver on every horse.

Store and Forge Carriage.—The carriage which under the designation of "store and forge," forms part of the establishment of our Troops of Horse Artillery, is very inapplicable to Indian Service, the forge is an encumbrance, and though a neat thing to look at in an arsenal or in a gun school, it is useless in the field; the native smiths will not use it, and there would be no profit in insisting on their doing so, they prefer establishing a forge on the ground, and squatting to their work after the fashion, which is I believe common to Natives all over India.

It would be well if this carriage were withdrawn from batteries, and replaced by a common "store cart with limber" of which each battery should have two, one of them at least being horsed, for if drawn by bullocks with the park, it will sometimes happen from its slow rate of travelling, that the greater part of the day will be lost before the materials arrive to enable the artificers to repair the damages of the preceding march

By a recent Government Order, four horses are allotted for the draft of the store and forge carriage at present in use, this carriage cannot be drawn on service by fewer horses than the other carriages of a Troop, and the attempt to move it with the reduced proportion would be found poor economy; the horses would be soon knocked up, for it must be remembered, that a store and forge cart in the Field is encumbered to a degree which would not be thought slightly, were the carriage exhibited packed (according to regulations) in the arsenal yard.

Where towns and villages afford no supplies of material, wood, iron, charcoal, leather &c. must be carried on, and the Captain Commanding is glad to pick up when he can find it, and carry on with him, a piece of timber suited to replace the next perch, shaft, or splinter bar, which he may happen to break.

Digitized by Google

Spare Carriage.—Instead of carrying so much of the spare component parts of Field carriages, it would be better to carry a larger proportion of spare carriages without Ordnance, the wear of an empty carriage in marching is very trifling; the most advantageous way of carrying a gun carriage is certainly upon its own wheels, and there can hardly be a difference of opinion, as to which is the most efficient.

Carriage for Troop Stores.—The allowance (three camels) for carriage of Troop stores in the Field is insufficient on service beyond the frontier, our regulations make no difference between Troops of Cavalry of about 70 horses, and those of Horse Artillery, which on foreign service have 230, besides the ordnance and carriages.

The Bengal method of carrying spare Field Gun ammunition is very superior to ours, where draft cattle can be had; it is this, each gun has three waggons complete with ammunition, one of them with the Troop, the other two in the Park; the convenience of this plan is very great, first to the battery, for the waggons being all exactly alike, can be exchanged at a moments notice when required, an empty waggon being drivenup to the park, and the full one taken away;—and secondly, to the Commissary's establishment, which is saved the heavy labour of packing night after night, and unloading and counting day after day, the ammunition when once placed in the waggons, is secure, and gives no further trouble;—Any arrangement which proposes to lighten the labour of a Park establishment in the field deserves consideration; in the best ordered Park much confusion will necessarily prevail, for packing and loading is generally performed during the night, and when camels are used as Park cattle, as was the case exclusively in the Army of the Indus, disorder is inevitable, the roaring of the camels, and the stupidity, unwillingness or perverseness of the drivers, create a scene of confusion, which should be seen to be understood.—The objection which may be offered to the Bengal method on the ground of its increasing the number of draft carriages, is more than met, I am of opinion in such circumstances as I have supposed, by tho advantages which I have stated; it should not be forgotten that it gets rid of a long string

Digitized by Google

of Park cattle, saves the establishment vast labour, and preserves the stores, which we know from experience are frequently lost during night marches with camels, on the latter point I would beg to refer the Board to the Commissary's list of stores thus lost during the late service.

Swords for Foot Artillery.—The Foot Artillery Soldiers sent on the late service were equipped with swords of the old pattern known as "Swords Havildars" "Gun Lascars," and a white waist belt and frog—the Bengal Foot Artillery also wore swords, but on a shoulder belt, the fuzils were returned into store before leaving India.

The sword was highly approved as a neat serviceable weapon, quite suited to Artillerymen with the guns, but the want of a small proportion of fire arms with each company was seriously felt, baggage guards on the march, and guards over the animals while grazing, could not mount with security unless well armed. It therefore became necessary to borrow a few muskets from the Infantry.

Fire Arms per Troop and Company.—Troops of Horse Artillery are equally in want of fire arms when on service, for the pistol is too insignificant a weapon to be relied on, 6 or 10 carbines per Troop, and the same number of fuzils per company would be a proper proportion.

Horses.—The experience of the late campaign has quite satisfied the Officers of our own Presidency, and I believe those of Bengal also, as to the relative value of the several descriptions of horses employed in the Artillery; the Gulph horse is best for general purposes, being excellent either in draft or saddle, temperate, generous, and hardy; the Cape horses were very unfavourably thought of before we proceeded to Affghanistan, but they have completely established their own character, they are equal to the Gulph horses in draft, but not so good in saddle; they proved themselves very hardy, and kept their condition remarkably well, perhaps better than any others.

Digitized by Google

Of several descriptions of country horses which the Provinces produce, few if any are found fit for Artillery draft, now that the Catawar breed is extinct.—The horses of Herat, Kandahar, Cabul, and other parts of Affghanistan are large and quiet, and when in good condition fine looking animals; but stript of their fat, they become poor creatures, and have no more the appearance than they have the stamina and disposition of the Gulph, or of the Cape horses.

But no description of horse has so disgraced our ranks as that which the Indian Government has expended so much money to produce, the horses from the Government Studs have been proved beyond all comparison the most worthless garrans with which the public service was ever encumbered.

In quarters where they have little work, plenty of forage, and ten pounds of gram daily they do well enough, they keep their condition, and being large horses they look well, and are popularly considered "an excellent gun horse," of course in marching from station to station in India, they sustain this reputation, and it would be strange if they did not, for they have a Commissariat in attendance to supply grain, forage is always procurable, and the rate of marching averages 10 miles a day over an easy country; let them however be brought suddenly or even gradually to hard work, to a precarious and scanty supply of forage, and to a reduced ration of grain, sometimes to none at all, it is under such circumstances that we discover their utter worthlessness; reduce their accustomed ration, and add a little extra work, and they at once lose their condition, and with it their willingness, they shew what is commonly expressed by the term "want of pluck," and they will not "face" a difficulty.

Thus the work which these animals are both unwilling and unable to perform, falls on the more capable and generous horses of the troop, who have already performed their share or more, under the same disadvantages, and the "Stud bred" are led or applied solely to "detachment work" in the hope of their picking up condition, this hope however is vain, nothing, as experience has shewn can bring them round, but rest and abundance of food.

Digitized by Google

The foregoing picture is not imaginary, it is taken from the actual state of the Artillery Brigade with which I served during the campaign to Cabul and back again; at one time I collected a great deal of information on this subject exhibited in tabular form, I have no copy of these papers by me, but a report framed from them has been made to the Commandant of Artillery, to whom I would respectfully refer the Board for information, which will I think bear out the opinion I have expressed.

Horses Foot Artillery.—On the formation of the Army of the Indus in November 1838, the Bombay Government sanctioned the purchase of 100 horses for draft of the Foot Artillery Field guns at a price of Rupees 350 each, and a Committee of which I was a member, purchased them, we found no difficulty in procuring at that price the description of animals that exactly suited our wants as Artillery, but were much perplexed by a condition which clogged our operations viz., that the horses purchased for Foot Artillery should be of a description fit for transfer to the Light Cavalry at the expiration of the service, this of course was an impossibility, for any horse fit for the Cavalry ranks would at that moment have fetched 450 Rupees, however the difficulty being explained and removed, 100 horses were purchased, amongst them were a few Arabs, but they were mostly well bred Persian horses undersized, that is to say 14 hands to 14-1, 14 to 14-2, principally about 14-1, but of a compact make and active, many of them would have passed for Arabs, and have proved in good hands excellent hacks or good hunters, of these 100-72 were allotted to a battery of 24 pdr. howitzers, and went through the whole campaign performing their work in the most extraordinary manner, considering the disadvantages under which they started, and were continued throughout the service.

In the first place, horsekeepers could not be got to go with them from Bombay, some coolies were at length procured, and the horses arrived in Scinde, under charge of men who (most of them) had never laid hands on a horse before; yet according to Government orders, and the exigencies of the case, they were to be the gun drivers; accordingly these half naked creatures were clothed

Digitized by Google

and drilled as far as circumstances would permit, the horses took kindly to their work, and in a few weeks, from being landed in India, they were actually marching through a foreign and difficulty country in draft.

As no camp followers could be procured in Scinde or Affghanistan, this battery throughout the campaign laboured under the disadvantage of an incomplete establishment of horsekeepers (who were also drivers) and as it never had a grass-cutter the horses were much worse foraged, than those of the other mounted Corps, the utmost exertions of the Officers were frequently insufficient to do more than procure a scanty feed, yet these little horses performed their work, drawing a 24 pdr. howitzer in a style which excited the admiration of the whole Army, the loss throughout the service (by death) was only one horse, and that one on a *post mortem* examination proved to have organic disease apparently of long standing.

Thro' Scinde we only put 6 of them in each carriage, as in the Horse Artillery, being 500 lbs. per horse in the guns, and 562 lbs. each in the waggons, but experience proved that it was better to drive 8 in each, and have fewer spare, accordingly from the Bolan pass this was done, the excellent performance of these horses may no doubt be mainly attributed to their youth and blood, but I think that much of it may be placed to the light weight of the drivers, lads with their few accoutrements averaging 8 stone, or perhaps hardly so much.

Bullocks.—The Bombay column had no heavy Ordnance with it after leaving the Indus, it was accompanied by a light Park, and the platform carts, spare waggons &c. were drawn by bullocks furnished by a contractor, who has long been in the Government employ, one-half were of the Mysore breed, the other from Guzerat; the former are certainly the best, and they endured well the privations of scanty forage and sometimes scarcity of water, the great secret in the management of bullocks seems to be in not hurrying them, give them time, rest them occasionally when tired, and they will be fully equal to any Ordnance work which can be required of them, I mean those of the Mysore breed, which I

Digitized by Google

consider to be the best draft animal for the Siege Train and Park, when it can be so arranged, they should perform their work during the night, but they must be allowed to creep along at their own pace, or they give in altogether, they are consequently unfit for the draft of Field Artillery.

Camels.—The Bengal Artillery had a battery of 9 pounders field pieces drawn by camels, this proved a complete failure when applied to general service. The Captain who commanded the battery (A. Abbott) was glad to exchange his camels for the small couutry horses of Cabool.

Camels are good Artillery draft animals in a dry level country, and they would no doubt work well in some parts of our Provinces, but they are not suited to a hilly country, and from what I have seen of their performance, I should say they would not answer for the Deccan, a steep ascent or descent stops them, and the gun must be taken by hand, a wet soil in particular is most unfavorable to them, they are doubtless faster than bullocks excepting in very difficult ground, but not to be compared with horses. Captain A. Abbott's report on the late camel battery is with Brigadier Stevenson.

Best draft, Field Guns.—Field Artillery to be efficient should be horsed: with bullocks it is from its slow pace an encumbrance, and an impediment to the Army, and would probably be found wanting at the moment when most required; on the contrary, a Field Battery horsed after the manner of the one which I have already described is more than equal to maintain its place with Infantry, indeed the Troops of Horse Artillery have little advantage over it.

The efficiency derived from the employment of horses over that of bullocks is in circumstances of difficulty beyond all price, for instance our 24 pdr. howitzer battery had, on the return from Cabool, marched 400 miles in 44 days, including halts, out of which 150 had been over the Khojee Amran Mountains by the most difficult tracks, hardly touched by a Pioneer, forage being exceedingly

Digitized by Google

scarce, and sometimes not to be had at all, and with a reduced ration of gram, *it had never during the whole of this march had a hand put to it by the Infantry*, and yet after all this severe work the little blood-horses went up the Ghaut near Quetta without aid and at a quick steady pace.

On the same march, the spare ammunition waggons drawn by long trains of tired bullocks, after having been brought on with great labour and manual aid, had on our arrival at Hydeergye, been left some marches in the rear, under a wing of a Regiment, to crawl on as they could, till met by some fresh cattle, which had been sent for.

The horse batteries always reached their ground early, the Park by bullocks, was continually so late, that European gunners could not have borne the exposure day after day in the sun, and had we on this occasion been retreating before an enemy, instead of pushing on to meet supplies, all the carriages drawn by bullocks must have been abandoned.

It cannot be expected that Government will incur the expense of maintaining a complete establishment of horses for all our Field Batteries, nor is it necessary, political considerations may render it so at one or two stations, but at the rest, the batteries might be equipped with a reduced permanent establishment of horses, say 50 to each, a number sufficient for the ordinary garrison duties of the whole battery, or for half a battery in the Field, having the nucleus permanent, no difficulty could be found in completing any number of batteries on a call for service.

Having thus touched in general terms, on the foregong subjects, I would respectfully beg the Board to permit me to suggest, that application be made on particular points as follows.

Pole versus shafts.
Double versus single driving.

These points were lately discussed, and a minute framed from the reports was made by Lord Keane, this minute, and accompaniments were delivered by His Lordship to Major Craigie, Deputy

Digitized by Google

Adjutant General Bengal Army, and I believe, Brigadier Stevenson has copies of them.

On the other several subjects, I am satisfied that much valuable information might be obtained from Major Lloyd, Captain Martin, and Captain Warden, the opinion of the latter Officer, would be deserving of much attention on spare carriages " Mode of carrying spare gun ammunition and bullocks."

A copy of this letter shall be forwarded to Brigadier Stevenson, C. B. with a request for his observations.

A.

Letter from Major P. Craigie, Deputy Adjutant General of the Army, with the Army of the Indus, to Lieut. Col. J. Stuart, Secretary to the Government of India Military Department. No. 99, dated Camp Jellalabad, 27th October 1839.

I have the honor by direction of His Excellency the Commander-in-Chief, to forward for submission to the Right Hon'ble the Governor General, copies of the papers noted in the margin, detailing the circumstances under which two horses of the 2d Troop, 2d Brigade Horse Artillery were lost, and animadverting on the superiority of the shaft over the pole in Artillery carriages.

1. From Major Pew to the Asst. Adjt. Genl. of Cavalry.
2. From Capt. Grant to the Adjt. of Artillery Division.
3. From Capt. Grant to the Brigade Major of Artillery.
4. From Major Pew to the Asst. Adjt. Genl. of Artillery.

His Excellency is aware that the two modes of placing horses in a gun have been attentively considered, and industriously canvassed by a Committee of Artillery Officers, but he deems it a duty he owes to the state, to place on record, not only his own opinion of the superiority of shafts over poles, but the sentiments of two unprejudiced and practical Artillery Officers, who have during the recent campaign, had ample opportunities of forming a judgment on the matter.

B.

Letter from Major P. L. Pew, Major Commanding Artillery, to Captain Bue, Actg. Asst. Adj. General Cavalry Division, dated Camp Bhoolkack, 16th October 1839.

I have the honor to report to you for the information of the Ma-

Digitized by Google

jor General Commanding, that in consequence of the bridge over the second nullah in to-day's route, having partially given way under the wheels of Captain Grant's second gun, that gun and its 6 horses were completely upset into the stream, and the heads of both the pole horses having been pressed down under water by the collar bar, these two horses were drowned, ere we could take them out of harness.

C.

Letter from Captain C. Grant, Commanding 2d Troop 2d Brigade Horse Artillery, to the Adjutant of Artillery Division, dated Camp Jauldock, 21st October 1839.

I have the honor to state, that the gun and carriage of the 2d Troop 2d Brigade Horse Artillery that fell into the nullah on the 16th instant, by the bridge breaking down was completely turned over, and am of opinion, that had the horses (wheelers) been harnessed in the shaft system instead of a pole, the near wheeler might easily have been saved, but not the off, or shaft horse.

I beg to forward the copy of a letter to the address of the officiating Major of Brigade Army of the Indus, dated 4th September 1839, recording my sentiments of the pole and shaft system.

D.

Letter from Captain C. Grant, Commanding 2d Troop 2d Brigade Horse Artillery, to Captain Coghlan, Major of Brigade, dated Cabool, 4th September 1839.

By desire of Brigadier Stevenson Commanding Artillery, Army of the Indus, I beg to forward my opinion regarding poles and shafts for Artillery carriages.

I consider shafts to be very superior to poles from the weight of the shaft being on the horses backs, whilst with poles, the weight is on both horses necks.

The ease with which carriages with shafts have crossed ditches, and gone down descents, and the difficulty experienced by car-

Digitized by Google

riages with poles, have been very apparent on the march from Candahar to Cabool, chiefly from the weight being placed differently, and the near wheeler with shafts having no weight to carry except his rider, whereas with poles, the wheelers, what with the weight of riders, and weight of pole on their necks appear to be, and are held down, and often fall.

E.

Letter from Major Pew, Bengal Artillery, to Captain Bue, Acting Asst. Adjutant General of Cavalry, dated Camp Sooker, 22d October 1839.

With reference to Major Craigie's letter No. 1004, to the address of the Major General Commanding the Cavalry of the Army of Indus, I have the honor to state for the information of His Excellency the Commander-in-Chief, that I consider the shaft system in the draft of field guns to possess many and great advantages over that of the pole.

In the pole system, each wheeler carries 16 stone upon his back, and 44 lbs. upon his neck, while in the shaft system, the off wheeler carries only about 100 lbs. upon its back, and nothing on its neck, the near wheeler carrying only its rider.

In going down hill, or through deep ditches or ravines, or over rough roads, the shaft system possesses great advantage over the pole one, as also in cases of accident, such as the wheelers falling, and I am of opinion, that in the fatal accident alluded to in Major Craigie's letter, had the shaft system obtained in our Horse Artillery, the near wheeler would not only have been saved from drowning, but the off wheeler also, because this latter horse's head could have been kept above water, until the animal was freed from harness.

F.

Remarks on a proposed new Carriage for General Miller's 24 *Pounder Light Brass Howitzer, Weight* 8 *cwt.* 3 *qrs. and* 4 *lbs.—By Lieut. J. Ash, Bombay Artillery.*

In the present carriage there is an axletree transom, as well as an elevating screw transom, which tend greatly to weaken the

Digitized by Google

carriage, as they are both sunk into the cheeks; further, close in front and rear of the elevating screw transom, two bolts pass through both cheeks; thus rendering them extremely weak on the very spot where there is most strain.

A drawing of two 24 pdr. howitzer carriages which broke down under their own fire at Dhoolie Khote (which I believe was sent in with the Practice reports for 1839 and 40) will prove that all the serious cracks originated from those points where the cheeks had been cut away to admit the transoms, or else where the elevating screw bolts pass through.

In the proposed carriage (of which I herewith transmit a plan and elevation*) there are no transoms, the cheeks are not cut away at the axletree, and elevating screw, and the front and rear bolts are nearly four feet apart. Instead of transoms I have introduced a cradle framed of two strong pieces of wood, which (together with the cheeks) is fastened together by three bolts, two of which are in front of the axletree (on which the cradle rests) and the third is about one foot in rear of the elevating screw, so that the immediate force of the strain is much better divided than in the present carriage, further to increase the strength of the carriage, the upper line of the cheeks instead of being straight, rise in curve (like that of the block carriage cheek) thus giving additional depth to the cheeks, between the axletree and elevating screw. Besides the three bolts, the cradle is kept in its place by 6 keys of hard and tough wood (3 on each side) which are slightly sunk into the cheeks and cradle about $\frac{3}{4}$ of an inch.

The elevating screw is so placed, as to be at right angles with the axis of the bore, when the howitzer has an elevation of 6? this position being the one best adapted to keep the base as near as possible on the centre of the capstan head, at high and low elevations.

The wheels—trail eye plate,—trail handles,—and elevating screw and box, are the same as those of the present carriage, the axletree band is the same, except that the front part is longer, and is bent up over the face of the cheek (as both of the carriages which

* Plan not given.

Digitized by Google

broke under their own fire, were cracked in that part of the cheek which is between the axletree and the face.)

I have not inserted a trail handspike in this plan, but should the carriage be approved of, I would suggest that it be fitted with an iron trail handspike, of the pattern in use with the Horse Artillery 12 pdr. howitzer carriage. The one at present attached to the 24 pdr. carriage almost invariably breaking off after a few rounds having been fired.

Should it be objected that the proposed carriage will be heavier than the present ones, I beg to submit for consideration,

1st. That the recoil and strain which a light gun occasions to its carriage, is always much greater than that of a heavier gun of the same bore, because there is less dead weight or power of resistance.

The light gun therefore should not have too light a carriage.

2d. That the present carriage is too light is manifest from the circumstance that one of the carriages which broke down at Dhoolia Khote, began to crack at an elevation of $2\frac{3}{4}$ and $3\frac{1}{4}°$ and was totally disabled at the 15th round at an elevation of 6°.

3d. The proposed carriage will not weigh 120 lbs. more than the present one, a difference so slight will not be felt by the number of cattle allowed for the draft of this piece of Ordnance, or prevent the men from working it, as quickly as the former one, and hardly deserves notice, in comparison with the great increase of strength and durability, which will accrue by the adoption of the cradle in lieu of the transoms.

Letter from Lieutenant Colonel J. STUART, *Secretary to the Government of India, Military Department, to Major* P. CRAIGIE, *Deputy Assistant Adjutant General of the Army, with the Army of the Indus, Ferozepore, dated Camp Jhinsi,* 14*th January* 1840.

In reply to your dispatch No. 99 of the 27th October last, I am directed by the Right Hon'ble the Governor General to transmit to you, for the information of His Excellency the Commander-in-Chief of the Army of the Indus, the annexed copy of a communi-

Digitized by Google

cation No. 489, from the Officiating Secretary to the Government of India in the Military Department at Calcutta, under date the 30th ultimo.

Letter from Major W. CUBITT, *Officiating Secretary to the Government of India, to the Secretary to the Government of India Military Department, with the Right Honorable the Governor General, dated Fort William, 30th December* 1839.

With reference to your despatch No. 82, dated 15th ultimo, and its enclosure (which last is herewith returned as requested by you) I am directed to transmit to you, to be laid before the Right Honorable the Governor General, the accompanying copy of a report No. 3255, dated 11th Instant from the Military Board, submitting their sentiments on the substitution of shafts for poles in Artillery carriages.

Letter from the Members of the Bengal Military Board, to the Honorable T. C. ROBERTSON, *Esq. President of the Council of India, in Council, dated Fort William, 11th December* 1839.

We do ourselves the honor of acknowledging the receipt of Officiating Secretary Major Cubitt's letter No. 33 of the 2d Instant, with its enclosures, desiring our sentiments on the substitution of shafts for poles in Artillery carriages.

2d. In drawing up the required report (for the materials of which we are indebted to the professional knowledge and experience of the Brigadier Commandant of Artillery) we have to remark *in limine*, that on taking an abstract view of the question, we labor under considerable embarrassment in forming an opinion thereon; the advantages or otherwise of Poles over shafts being so nearly balanced, some European Armies using the one, and some the other. The English have shafts while the French have poles, and other continental armies in canvassing the merits of the present pattern English carriages, suggested the substitution of the latter for the former, as an improvement to them.

3rd. If Horse Artillery were always to be employed in going up and down ravines, we think the shafts might be preferable;

Digitized by Google

but in tolerably level country, even with the worst roads, or none at all, we consider the pole best, as giving more freedom of action to both wheelers. We are aware of the predilection for shafts in the Officers of the Bombay Horse Artillery, but two thirds of the special Board of Artillery Officers, convened in 1836, preferred poles,* and in this opinion the Commander-in-Chief coincided as did also Colonel Morrison.

4th. In support of the position we have advanced, we would adduce as illustrations, the two Troops of Horse Artillery employed in the War in Affghanistan; in the 2d Troop, 2d Brigade, the carriages of which were strictly according to rule, the pole horses were at first much galled at the top of the neck; but in the 4th Troop 3d Brigade, a modification adopted by Major Timbrell (of the advantages of which we have satisfied ourselves by a personal inspection) proved exceedingly beneficial, and a report received by the Brigadier Commandant of Artillery, from the Officer Commanding the Troop, after he had taken it across the Hindoo Coosh, is quite silent regarding any inconvenience experienced from poles, but it is conclusive upon other points. We take leave to make an extract from the report alluded to, which is dated Bameean, October 18th, 1839.

"The greatest of these improvements is the removal of the store "boxes and the heavy bar in rear of the splinter bar, removing a "great weight from the horses necks, the best proof of this is, that "not a single horse of this Troop is galled on the top of the neck."

5th. We conceive it necessary before concluding, to make one more remark, which is applicable to the Bengal Horse Artillery exclusively, and which we are of opinion is the weightiest objection that can be urged to shafts, and that is the great inconvenience which would result from doing away with the rider of the off pole horse.

6th. The original enclosures received with the letter under acknowledgment, are herewith returned.

* Vide proceedings pages 10-102.

Digitized by Google

Letter from Major P. L. PEW, *Commanding Artillery Division, to Captain* BACKHOUSE, *Major of Brigade, Bengal Artillery, dated Camp Ghizni, 25th July* 1839.

In forwarding for the information of Brigadier Stevenson, Commanding Artillery Army of the Indus, copy of a letter just received from Captain Abbott, Commanding camel battery, to my address, I beg to state, that the Commissariat have promised to furnish 15 camels this evening, out of which number I will select 10 to complete the battery.

Were it even expedient to give horses to the guns of the battery, I do not perceive how it could be done at the present moment, when we are on the eve of marching to Cabul, as the horses captured in Ghizni are unbroke to draught, and the poles and splinter bars of the 6 guns would have to be cut down, ere horses could be applied to the limbers.

Deeming the white boosa on which the camels of the battery have been fed, prejudicial to the health of the animals, I should esteem it a favor, were His Excellency the Commander-in-Chief to direct, that the camels of the battery be fed on Jowasa, the camel thorn, which is always procurable—and I should think that a daily sum, equal to that now expended in purchasing white boosa, properly applied, would command an abundant supply of it.

The camel once in good flesh, and in the daily receipt of its proper fodder (Jowasa) I should apprehend no failure even on these difficult roads, but should unfortunately the anticipations of Captain Abbott prove correct, we have plenty of spare bullocks in the park, to ensure the battery reaching the provinces, should the worst come to the wosrt.

Letter from Captain A. ABBOTT, *Commanding No. 6 Light Field Battery, to Major* P. L. PEW, *Commanding Artillery Division, dated Camp Ghizni, 25th July* 1839.

SIR,—With reference to the present condition of the camels of my battery, and to the fact that horses are procurable to any extent at this moment, I venture to suggest, that the guns of the battery be equipped with horses, and the whole of the camels be made available for the waggons only.

Digitized by Google

My opinion of the battery as it now stands, is, that as a ligh field battery it cannot act in this country; because it cannot keep pace with the Infantry, and altho' it may crawl on to Cabool at a slow pace, I doubt its being able to return to the Provinces from that capital.

A sufficiency of harness is available for the purpose in question; I have regularly trained syce drivers amongst my Sowars, and there will be no difficulty in carrying the arrangement into effect should it be sanctioned.

A comparative trial of horse draught, on the least efficient scale, with camel draught, will also be made ere we return to the Provinces.

As no time is to be lost, I at once state the number of horses required to be 8 for each carriage, 6 in draught and 2 spare, or 50 or the 6 guns of the battery.

I shall be much obliged if you will forward my letter to Head Quarters—thro' the regular channel, unless you think it proper for the mere sake of an experiment, to take on active service a battery whose cattle are quite inefficient on the road on which they are required to travel.

Letter from Captain A. ABBOTT, *Commanding Camel Battery, to Major* P. L. PEW, *Commanding Artillery Division, dated Camp Ghizni, 27th July* 1839.

As I am given to understand, that in forwarding my letter of yesterday's date, you have stated certain objections to my proposal, which objections are easily replied to, I will be much obliged by your forwarding this letter to the consideration of Brigadier Stevenson.

1st. As there are spare poles both in the Park and in the Troops of Horse Artillery, there will be no occasion to cut down the camel poles, until the horses shall be perfectly well trained.

2d. The splinter bars need not be cut down at all, the addition of two iron loops to each bar, will fit them either for camel or horse draught, and the job can be done in a day.

With regard to the battery being supplied with bullocks in case

Digitized by Google

of the camels failing, I am informed by Captain Day that he has neither yokes nor traces to spare from the Park ; and my application for bullocks to relieve the camels in draught to the spare waggons and stores carts, was negatived by yourself for this reason.

Letter from Major P. L. Pew, *Commanding Artillery Division, to Captain* Backhouse, *Major of Brigade, Bengal Artillery, dated Camp Ghizni, 28th July* 1839.

In forwarding for the information of Brigadier Stevenson, Commanding Artillery Army of the Indus, copy of a letter, of yesterday's date to my address, from Captain Abbott, I beg to state, with reference to yokes and chains, that I contemplated aiding the camel battery from Cabul to the Provinces with bullocks, if necessary ; conceiving that much of the Park would be left at Cabul, and that both spare yokes and chains would be available there.

In respect to poles, I was not aware that any could be spared from the Horse Artillery, we have only 5 with the Park, and even all these could not be spared.

Letter from Captain A. Abbott, *late Commanding Camel Battery, to Captain* Coghlan, *Bombay Artillery, dated Camp Cabul, 13th September* 1839.

Agreeable to the wish of Brigadier Stevenson Commanding Artillery Brigade, I have the honour to make a general report on the performances of the camels of the late camel battery.

On hard level ground, I found that 4 camels were equal to the draught of a 9 pdr. even with its Artillerymen mounted on the boxes and seats. The dry canal beds that we crossed between Ferozepore and Roree were in general easily passed, the Artillerymen on such occasions being dismounted, indeed I did not allow them to ride after the battery quitted Ferozepore.

On such roads the camels kept pace with the Infantry, and could at the end of the longest march preformed at the rate of 3½ miles an hour, have manouvered at a good trot.

In deep sand, 4 camels proved unable to draw the guns at any

Digitized by Google

but a pace too slow for a Light Field Battery, and on continued ascents however slight, they have always failed to maintain a proper pace. It is therefore evident to me, that not less than 6 camels in draught can be allowed per carriage, and to those must be added 2 spare or 96 for the whole battery.

The obstacles most to be dreaded by an officer Commanding a camel battery are nullahs, canals, or watercourses intersecting a sort of clay. I have been sadly delayed by an apparently insignificant watercourse, and have more than once had to take out my cattle to cross a stream of that sort, which delayed no other cattle, and across which, baggage camels easily stepped, the check of the traces caused the camels (in draught) to step short and they fell very awkwardly.

I am not of opinion that any reasonable number of camels will move a camel battery at Infantry pace over a hilly country, the manner in which I have seen the camels fall dead in their harness immediately after surmounting steep ascents, convinces me that the animals will always be at fault on similar ground. The horse guns moved up these ascents without any check or material diminution of speed, and although the 6 pounder gun is much lighter than the 9 pounder, there is little difference in the weight of their waggons, and waggons formed the main portion of my column.

In very sandy countries, I think camel batteries would be most valuable, for the feet of the camels do not sink in soft sand. But a liberal allowance of cattle must be made for such roads, the camel draws almost entirely by his weight, and cannot use continued muscular exertion without great distress.

My camels found no difficulty in crossing streams with sandy or pebbly bottoms, and they passed some formidable torrents without flinching, though the water was 2 feet 10 inches deep, and several soldiers were washed away and nearly drowned at the same ford.

The camels stand fire with perfect indifference, they can sit down (in draught) and thus be secured by a low wall, or in a hollow from an enemy's fire, they can abstain from water for 48 hours under severe work, and do not immediately suffer as other cattle do from the loss of a day's food.

Digitized by Google

Casualties will not be very frequent, if the cattle be confined to particular districts, they are easily and cheaply recruited.

I think therefore that camel batteries may to a certain extent supercede bullock ones in our Upper Provinces only. The extent I pretend not to define, but it must be borne in mind, that they cannot be depended on for protracted service, beyond the territories, and no animals but horses should ever cross the Indus with Field Batteries proceeding on service.

I must not omit to mention that none but high cast camels, such as the Bangor and other classes of Suwaree camels will ever answer well for draught, as far as I can judge from experience, but these are plentiful in the country for which camel batteries are best calculated.

The above report is the result of about 15 months' experience, in the course of which I have tried about 200 camels. It must be remembered however that I have not marched in rainy weather, and further trial of the animal will be required to establish, whether a camel battery could march during the rainy season, should my report give rise to a wish on the part of Government, to exchange any of their bullock batteries, for batteries drawn by camels.

Letter from Captain C. GRANT, *Commanding 2nd Troop 2nd Brigade Bengal Horse Artillery, to Captain* COGHLAN *Bombay Artillery, dated Camp Cabul, 4th Sept.* 1839.

By desire of Brigadier Stevenson Commanding Artillery Army of the Indus, I have the honor to forward my opinion regarding poles and shafts for Artillery carriages.

I consider shafts to be very superior to poles, from the weight of the shafts being on the off horses back, whilst with poles the weight is on both Horses necks.

The ease with which carriages with shafts have crossed ditches, and gone down descents, and the difficulty experienced by carriages with poles, have been very apparent on the march from Candahar to Cabul; chiefly from the weight being placed differently, and the near wheeler with shafts having no weight to carry except his rider; whereas with poles, the wheelers, what with the weight

Digitized by Google

of riders, and weight of the pole on their necks, appear to be bored down, and often fall.

Letter from Major P. L. PEW, *Commanding Bengal Artillery, Army of the Indus, to Brigadier* STEVENSON, *Commanding Artillery, Army of the Indus, dated Camp Cabul, 13th Sept.* 1839.

I have no hesitation in declaring, that I consider shafts far superior to poles, with horse draught in our Light Field Guns. By shafts the weight now supported on the necks of our horses in the Bengal Horse Artillery, is at once removed to the back of the off wheeler, which horse has nothing further to support, while the near wheeler carries the weight of his rider only.

I at one time preferred poles to shafts, but after seeing that guns with shafts can go to the left about at a brisk canter with great facility, and otherwise manœuvre beautifully; and that in going down hill or steep ravines, or through deep water cuts, they possess great advantages over the pole guns, I have altogether changed my opinion.

Letter from Captain A. ABBOTT, *Commanding No. 6, Light Field Battery, to Captain* COGHLAN, *Bombay Artillery, dated Camp Cabul, 14th September* 1839.

In compliance with the desire of Brigadier Stevenson, that I should record my opinion as to the relative merits of poles and shafts, as used by the Artillery in our camp, I beg to say, that in steep descents the shaft horse evidently possesses greater power of checking the descent of the carriage, than can be exerted by the pole horses; this I observed very frequently on the march; the pole horses were frequently obliged to gallop down hill, to avoid the run down by the carriage, and the splinter bar continually came in contact with the hind quarters of these animals. The shaft horses were always able to prevent the too rapid descent of the carriage; and the manner in which the breeching is fixed, renders it impossible that the splinter bar should ever touch them.

Descents.

Digitized by Google

Ditches. In crossing ditches the weight of the pole upon the neck, often threw down the pole horses, and held them down; while the shaft horse carrying the weight on his back, had all his fore hand free, and stepped into and out of the obstacle with, little more difficulty than he would have experienced with merely a rider on his back.

Turning. Corners. The shaft horse also, has more power over the carriage in turning, than can be exerted by the pole horses; and here the advantage of driving comes into play, the directing power being lodged in *one* person who has complete command over both horses.

The above are advantages (of the shafts) which have become apparent in the course of our march, I avoid all theoretical speculations, because such are liable to dispute. In the Upper Provinces of India where the ground is level, and the roads are generally open, it matters little whether poles or shafts are used,* but in difficult ground, where the safety of a gun depends so frequently upon its wheels following with critical nicety, a given line, the test is applied in a manner which can leave no doubt as to the superiority of the shaft, in the minds of those who witness the experiment.

* Note—But even on level ground the weight is better carried on the *back* than on the neck, this I believe is so generally admitted, that I have not touched upon the subject in my letter.

In speaking of descents I of course do not advert to those which are so *very steep* as to require the locking chain to be used.

Digitized by Google

Miscellaneous.

Doctor O'Shaughnessy on Lightning Conductors.

fig. 31

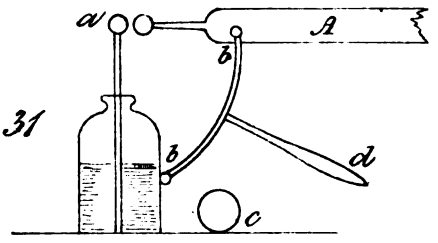


fig. 32.

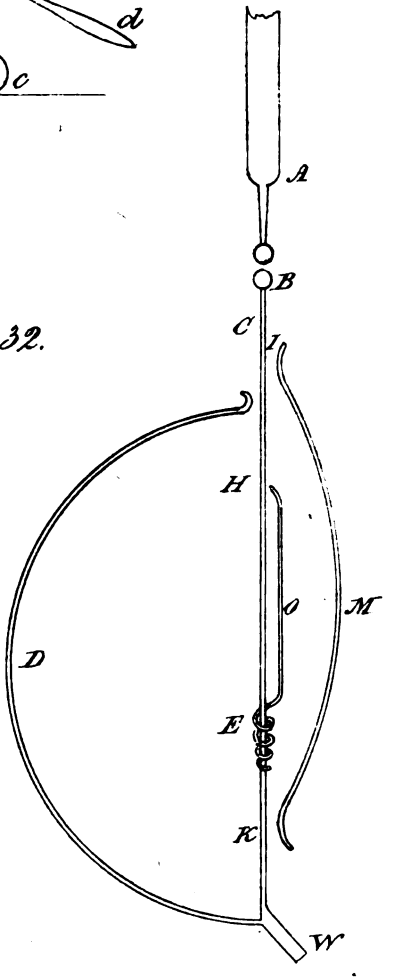
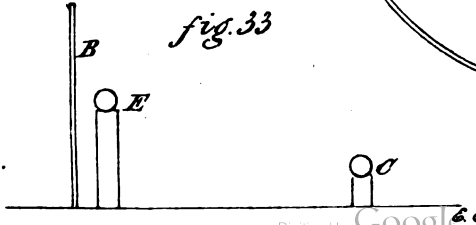




fig. 33



Digitized by Google

Digitized by Google

Digitized by Google

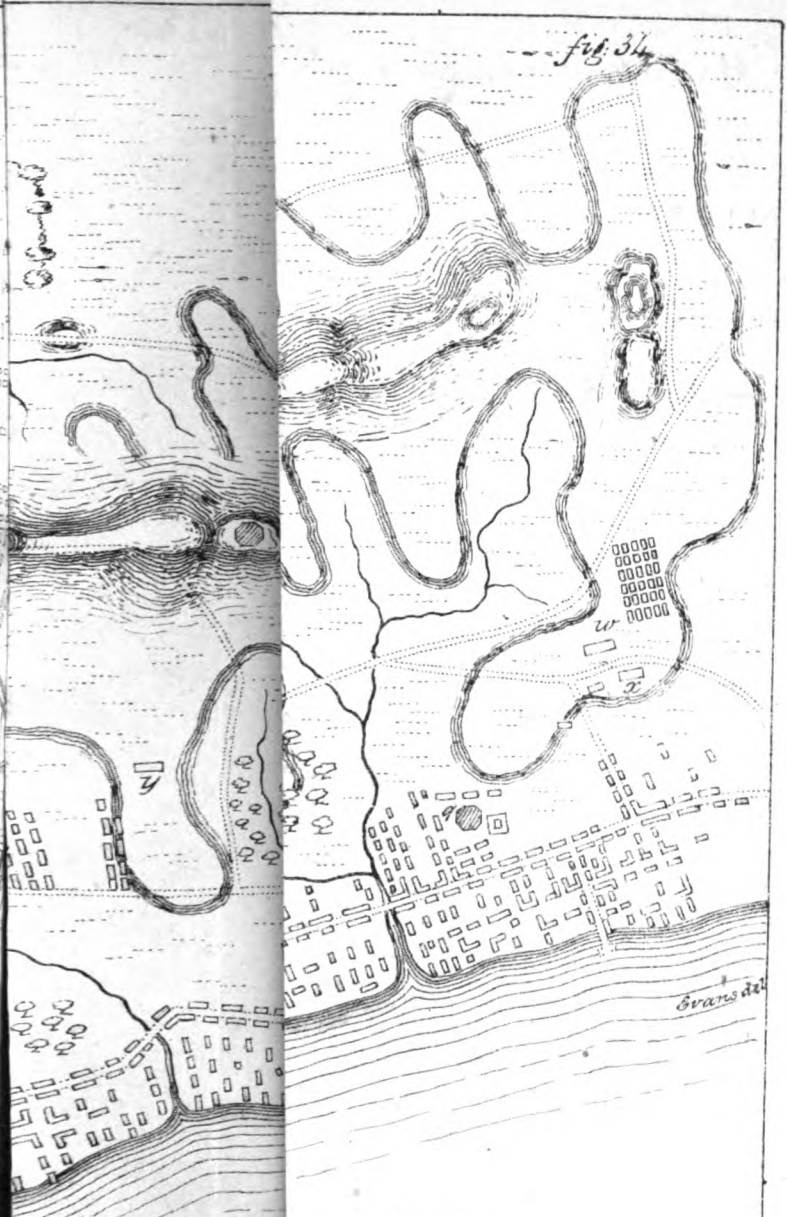
Miscellaneous.

MILITARY SKETCH
—of—
the CANTONMENT of
MAULMEIN.



Digitized by Google

fig. 34



a Barrac... I.
b Hospita...
c Barrac...
d Hospita...
e Park g...
f Arsen...se
g Main ...
h h. Comm...
i Lines. ...

t Mess House.....
u Officers Quarters.....
w Lines 44th Regt N.I.
x Mess House.....
y Talien Corps.....
z Botanic Garden.....
1111. Picquets.....

Digitized by Google

Digitized by Google

CAMEL BATTERY.

Military Letter from Bengal, dated 20th July 1839, No. 55.

Para 1. We have the honor to transmit for the information of your Hon'ble Court, a series of papers marginally numbered, on the subject of camel draught, as applicable to battering trains and Artillery purposes.

2. The long continued and spirited experiments of Major Pew, of the Artillery at Delhi, on camel draught, as applicable to that arm of the service, induced the Commander-in-Chief in September 1837, to propose to the Right Hon'ble the Governor General, that the results of that Officer's efforts should be practically tested. His Excellency being then on the eve of proceeding on a tour of Inspection, requested and obtained the Governor General's sanction to having the two guns, which were at that time complete at Delhi, dispatched with their equipments to accompany His Excellency's escort, as a means of enabling him to afford to the Government a decided opinion on the performance of camels in draught.

3. Accordingly, one 9 pounder gun, one 24 pounder howitzer, and an ammunition waggon, all completely laden with their proper portion of ammunition for service, joined the Commander in Chief's camp at Hansi, and were instructed to follow the rear of the squadron of Cavalry of His Excellency's escort.

4. They continued to do so from Hansi to Delhi, ten marches of a tract of country, where there are no made roads, where occasionally the sand was very deep, and the track such as is met with on an average in the west of India.

5. They appear to have kept up with the Cavalry with great ease, and His Excellency after strict personal observation, reported of them in the most favorable terms, stating the result of this march of one hundred and ninety-one miles to be a convincing proof of the applicability of camels to the draught of Artillery, and of the efficiency of the manner in which Major Pew had equipped them.

6. Judging from this experiment and a smaller one made at

Digitized by Google

Delhi, on a 9 pounder gun loaded with ammunition to the weight of 48 cwt. moved with ease by 4 camels, the Commander-in-Chief expressed himself decidedly of opinion, that the camel battery would be, beyond all comparison superior to one drawn by bullocks on actual service, and that in most cases, in the west of India 9 pounders, equipped like those under His Excellency's inspection would be a most useful auxiliary to Cavalry.

7. A report by Captain Anderson on the camel draught as compared with that by horses and bullocks, was submitted by His Excellency, representing very favorably the capabilities of the former animal.

8. Subsequently His Excellency was led, by some suggestions of the Governor General, to express his opinions, founded in general on observation and experience, on certain characteristics of the camel, having an important bearing on its adaptibility to the purposes of Artillery on service. Its peculiar liability to accident on slippery ground, its temper, its supposed susceptibility of disease under change of climate, comparatively with oxen, and its nerve under actual fire. Your Hon'ble Court will find in His Excellency's communication, consultation 19 March No. 4, of the marginal numbers, a view of these points and others connected with the subject, which appears to be reasonably and justly taken, and was indeed subsequently in part, borne out by actual experiment.

9. In the same communication, His Excellency proposed that Major Pew should be ordered from Nusseerabad to Delhi, to detail the organization in every respect of a complete battery of 9 pounders, to be placed under a selected officer and put to work with the Delhi Brigade of Infantry, in order to a minute and fair trial of the efficiency of such a battery, with accurate details of its comparative cost.—This arrangement was sanctioned.

10. In No. 5. of the same consultation, your Hon'ble Court will observe an interesting detail by Major Pew, of his march from Delhi to Nusseerabad, a distance of 244 miles, performed in 15 marches, with a 9 pdr. gun drawn by camels, presenting an additional satisfactory instance of the efficiency of this species of draught.

Digitized by Google

11. No. 7 of the same consultation contains a statement of the actual cost of the camels which accompanied the guns and carriage with the Commander-in-Chief's escort abovementioned, from their departure to their return to Delhi, a period of 41 days, as compared with what would have been the cost had the ordinary number of bullocks been made use of. The result proves in favor of the camel draught by about one-fifth.

12. In No. 203 of consultation, 14th May 1838, Major Pew reports another successful experiment in the march of a 9 pdr. drawn by camels from Nusseerabad to Delhi, in 10 marches, having travelled through heavy sand at the rate of about 25 miles a day for ten successive days. The camels though without forage on this march, were not at all fatigued at the end of the journey.

13. Your Hon'ble Court will observe in No. 205 of the same consultation, a statement in detail of the number of men and animals sanctioned for equipping the experimental battery at Delhi, mentioned in paragraph 9 of this letter.

14. Captain Abbot the Officer in Command of this battery, having been ordered on service with the army of the Indus, the Commander-in-Chief took the opportunity to recommend, that the battery should be completed in all its draught equipment for the field with camels, and that Major Pew should be permitted to organize it according to his own views.

15. His Excellency further recommended that Major Pew should be authorized to equip one 18 pounder, and one 8 inch mortar and their trains with camels, so that a just comparison might be made between bullocks and camels both as respects cost and efficiency.

16. The Governor General was pleased to sanction both these proposals in August 1838. In October following however, Major Pew reported his having been obliged to abandon the equipment of an 18 pounder for camel draught, by failure in the harness and want of time and means to make up such as could be depended upon on service. The equipment of the 8 inch mortar was completed.

Digitized by Google

17. Your Hon'ble Court will perceive with much satisfaction, that in December 1838, the Commander-in-Chief made a very favorable report of the success of these experiments on camel draught; the 9 pounder battery having kept up with two Regiments of Cavalry from Delhi to Ferozepore without any difficulty or damage, having taken its post in line at the latter station under His Excellency's observation, and manœuvred with as much facility as other batteries, the animals appearing perfectly tractable and as steady as animals usually are under fire. His Excellency in short declared an unqualified opinion, that under all the circumstances under which he had seen them, the camels have greatly the superiority over bullocks.

Letter No. 465, *from Major General* J, R. LUMLEY, *Adjutant General of the Army, dated Kurnaul* 19*th December* 1837 *: to Major General Sir* W. CASEMENT, K. C. B., *Secretary to the Right Honorable the Governor General, Military Department.*

I am instructed by His Excellency the Commander-in-Chief to request, that you will lay the following statement before the Right Hon'ble the Governor General and the Council.

No. 149
9th October 1237
Camel Artillery.

In conformity to the sanction given to His Excellency, conveyed in your Letter as per margin, he ordered one 9pd. gun, one 24 pdr. howitzer, and an ammunition waggon all completely laden with their proper portion of ammunition for service, and the gunners for manning the guns, to be equipped in the manner proposed by Major P. L. Pew of the Regiment of Artillery, and to join his Camp at Hansi, under the Command of an intelligent Artillery Officer capable of carefully noting the result of the trial, during His Excellency's march to the southward.

Captain W. Anderson of the Horse Artillery, accordingly joined him, with the Artillery aforesaid at Hansi.

On inspection, His Excellency found each gun and the waggon, equipped with 4 camels, and one spare camel for each set.

In consequence of the sanguine manner in which Major Pew had spoken of the camels, as beasts of draught, His Excellency order-

Digitized by Google

ed, that the Artillery should not march with the Infantry part of his escort, but that they should follow the rear of a Squadron of Cavalry.

They continued to do so from Hansi to Delhi, ten marches over a tract of country, where there are no made roads, where occasionally the sand was very deep ; and over such as may be taken as an average sort of track for the west of India.

His Excellency frequently paid attention to them, on the line of march, and he found them to keep up with the Cavalry with great ease. When the roads were tolerable they kept up, at the trot of the Cavalry with equal facility ; and they were very little retarded by the deepest sand which presented itself on the march ; or by places which would (His Excellency thinks) have brought 8 horses to a stand, with the same weight behind them.

Their draught is remarkably steady, and they are very tractable in the guns.

On concluding the march at Delhi, which amounted to one hundred and ninety-one miles, the condition of the animals was not in any degree deteriorated; but one was at all galled by the harness, and that one but very slightly, owing to a palpable fault in the collar ; not one was lame, or had failed in any degree. The damage occasioned to the harness, did not amount to ten rupees.

His Excellency therefore considers the march, as far as it extended, to be a perfectly convincing proof of the applicability of camels to the draught of Artillery ; and of the sufficiency of the manner in which Major Pew has equipped them.

At Delhi, Major Pew paraded for his Excellency's inspection, another 9 pounder, loaded with ammunition to the weight of 48 cwt., four camels moved this gun up hill, (on a very good road) with the utmost ease, at a regular marching pace, of near six miles an hour, without any extraordinary urging, and they concluded their performance by trotting, somewhat more than a mile at a rate, certainly exceeding 12 miles an hour, and such as kept the accompanying horsemen at a good gallop. The animals were not at all distressed when halted.

Digitized by Google

These facts have been all witnessed by His Excellency, he instructed me to state, that he does not hesitate to say, that the camel battery would be beyond all comparison, superior to one drawn by bullocks, on actual service, with an army ; and that he thinks, that in most cases in the west of India, 9 pounders equipped, as the guns under his scrutiny have been, would be a most useful auxiliary to Cavalry.

Accompanying is the report, made by Captain Anderson, the Officer of Horse Artillery, who was placed in charge of the guns.

His Excellency does not deem it necessary to offer any suggestions arising out of these detailed facts, until he shall receive further instructions from the Supreme Government.

Letter from Captain W. ANDERSON, *Artillery, dated Camp Delhi, 4th December* 1837, *to Major General* J. R. LUMLEY, *Adjutant General of the Army.*

I do myself the honor to forward a report on the traction of the camels attached to the guns under my charge, towards the prolixity and imperfections of which, I solicit the indulgence of His Excellency the Commander-in-Chief.

With respect to the particular points of your letter of the 2d Instant, I beg to add, that, with one exception, solely attributable to the state of the collar, no galling whatever has been experienced. The harness has failed in no single instance, beyond the trifling accidents, incidental to even harness of the most perfect description ; no part, important to the principle of the present traction, has failed ; and a trifle of eight or ten rupees would cover every expense of repair.

My limited experience does not enable me to determine between the collar and body traction, over hard roads I could perceive no difference ; but on occasions of deep sand, it did strike me, that the camels in body traction, laboured and twisted more than those with the collar ; and generally that more exertion was obtained from the former ; which I account for by the short, constant and unelastic nature of the traction : no appearance of falling off in condition is visible, which could alone evince any disadvantage,

Digitized by Google

under which the animal labored, this must be ascertained by a prolonged trial with two guns, each under one of these two descriptions of harness.

Over sandy roads, with the favorable weather we have experienced, the camels appear well calculated for the traction of Ordnance; and their advantage would be more fully experienced with guns of the largest calibre.

Appendix A. will afford a detailed account of each days performance, shewing a distance of 191¼ miles in 17 days, at a rate of 11¼ miles per day, in 3 hours 9 minutes, or about three and a half miles per hour.

Appendix B. contains weights and measurements peculiar to camel traction.

REPORT BY CAPTAIN W. ANDERSON.

Before attempting any comparison, it may be as well to ascertain, the real state of the object in view, both with respect to the powers of the animal and the difficulty to be overcome.

The word draught is applied in common acceptation, both to the force applied, and to the resistance to be overcome; but in an investigation of the present nature, it is necessary to define the terms used. Draught will therefore be applied to the resistance, and traction to the power.

The present object is, the motion to be given to a heavy body supported by wheels; the resistance to this motion, or the draught, is resolved into two distinct causes.

Friction of the wheel round the axle, called, *Friction at the centre*; secondly, the opposition offered by the surface, or ground over which the wheel moves, called *Friction at the circumference.*

Friction at the centre is considered as proportional to the superimposed weight, and varies according to the substances in contact; between iron and brass well oiled, it is usually estimated at 1-5th of the weight, which is again decreased in the ratio of the radius of the wheel to the radius of the axle; hence the advantage of the largest wheel with the smallest radius of the axle.

Digitized by Google

Friction at the circumference varies according to the nature of the surface ; and is further decreased in the ratio of the square root of the radius of the wheel. The advantage of large wheels is less here than in the former case.

The diameter of the wheels and axle being already settled, it is unnecessary to bring them under consideration. But the surface or state of the road, is of greater importance than is usually attached to them ; if we pause and consider well the following results ; after deducting the amount of friction constant in each case the power required to move a waggon of 1000lbs. weight was as follows.

Over Turnpike road, hard	181bs.	1·
,, ,, ,, , dirty	26 ,,	1 ,, 4.
,, ,, ,, new gravelled	130½ ,,	7 ,, 2.
,, ,, ,, , loose sand	191 ,,	16 ,, 1.

This latter, being the general state of Indian roads, is worthy of the greatest attention. The above two causes, combined under the term draught, remain constant, whatever be the animal power used ; it is therefore unnecessary to enter further on the subject. The question being,what is the best mode to overcome the draught.

No important subject has been less investigated, to satisfactory conclusions, than animal power. The circumstances under which it is exerted, being so various, and their combinations so numerous, that the result can hardly be measured by any fixed standard.

Throwing aside other modes of application, the power exerted in traction by the horse is subject to three grand variations, velocity, duration, and the various combinations of these two.

It is evident that a point exists, to which either may be pushed, to the extinction of all utility ; from which, the effect increases, thro' a medium, to the highest point ; but there exerted to the injury of the animal, in extracting from him, his utmost possible exertion, which can never long be maintained for any useful purpose.

The medium, or point of more useful effect, is considered as half velocity ; which, for the same duration, an unloaded animal could be forced to maintain without injury to himself.

Digitized by Google

In the case of the horse, experiment has fixed as the point of most utility, a velocity of 3 miles per hour, for a duration of 6 hours per day. The power exerted under this combination being established as the point of 125lbs.

Duration.	Velocity.	Relative Value.	Actual Weight.	
Constant to 6 hours	3	125	6 Cwt.	
	4	83	....	
	5	41	....	
	6	0	....	

With respect to duration, the velocity continuing constant, any decrease below 6 hours, would be attended with loss of effect, while any increase, beyond 8 hours, would be attended with injury to the animal, a happy combination of those two, must therefore be ascertained, for the horse to exert his highest power of traction.

The following is the table of velocity and duration, usually received for a horse, exerting his full power of 125 lbs.

Duration.....	1	2	3	4	5	6	7	8	9	10
Velocity.....	14¼	10½	8½	7½	6⅝	6	5½	5¼	0	4⅜
Best point for effect...	7⅛	5¼	4¼	3¾	3⅓	3	2¾	2⅝	0	2⅛

To obtain any increase, the animal must be called upon, to exert a proportionably less power of traction; 125 as exhibited in the above table, is the amount, at low velocity for waggons, which for higher velocity, is reduced to 62 and 40, the former for heavy coaches the latter for mails.

This is not to be considered the actual weight drawn, but merely the measure of the power exerted, because one pound of weight will in favorable circumstances, with the assistance of wheels move from 1 to 30 lbs.

The average of the power required in the four states of road, abovementioned gives 104; or 1 lb. of power to 10 of actual

Digitized by Google

weight, now we may estimate the actual weight, drawn at a low velocity as 6 cwt. or one pound of the horse's estimated value, in traction, as equal to $5\frac{3}{10}$ of actual load for waggons; this will give 3 cwt. for heavy and 2 for light coaches. If the actual weight does exceed this, it must be borne in mind, that the deviation is decreased to meet it, the mails seldom exceed stages of 8 or 9 miles, although the velocity is 10 miles per hour, moreover half the number of horses is allowed spare. The light cart used in the trotting matches, weighed 40 lbs. and with the driver about 150 lbs.

The carrying powers of individual horses, vary to a great extent; but may be considered, under equal velocities and durations, as $2\frac{1}{3}$ of the drawing power; giving 2cwt. 2 qrs. 22 lbs; or 20 stone for the pack horse; 11 stone for the roadster and hunter; and 7 stone for the race horse, on whom the effects of a few pounds are well known.

By these hypothesis let the traction of the Horse Artillery be examined.

Taking the average of a troop from Dum Dum to Meerut; it marched 86 days, giving $11\frac{3}{6}$ miles per day; a second troop marched from Cawnpore to Meerut, in 25 days, giving $11\frac{1}{4}$ for the days work; the medium being $11\frac{7}{8}$: as the pace is 4 miles per hour, it gives a duration of 3 hours, which exactly coincides with the useful point of effect in the foregoing table. But the power, which each horse was called upon to exert, is far beyond 125lbs. there established; while from recollection of the condition of horses, after long marches, or a protracted season of severe work, I have no doubt it was above the medium power. Each horse did draw 6 cwt. and carried on his back 2 cwt. which latter augmented by the drawing to the carrying power, gives a total draught of 10.4 cwt., which in the proportion of the scale, shews each horse to have been exerting 208, or $\frac{3}{7}$ more than his medium; this can only be accounted for, by the number of spare horses, and that the work is not constant.

Let an attempt now be made, to examine the traction of the camel, by the foregoing data.

To outward appearance the camel has greater weight than the

Digitized by Google

horse or bullock, but not to the extent his height would lead to be expected. The length of the strain on the hind legs, is much greater, while the muscle to withstand it is proportionally less, betraying vast inferiority to the horse in activity and powers for velocity; hence I am inclined to think, that the power for traction will not bear the same ratio to the power for carrying.

The variations in his velocity will not be found numerous, but in duration a great superiority exists.

The highest velocity which could be obtained from the unloaded animal, is 7 miles per hour; this perhaps is a maximun of speed; while 6 miles per hour, for a duration of 6 hours, giving a daily distance of 36 miles, is the rate gone by a good Suwaree camel with ease. In this, from the facility of the animal to bear burdens; the weight of the rider may be lost sight of, and the animal considered as unloaded. Hence $3\frac{1}{4}$ miles, for a duration of 6 hours, will be found the corresponding useful point.

Duration.	Velocity.	Relative value.	Actual weight.	
Constant to 6 hours	$3\frac{1}{2}$	187	9	
	4	163	.....	
	5	130	.....	
	6	109	.....	
	7	0	.....	

With respect to duration, the velocity continuing constant, the same remarks apply as to the horse. The most favorable combination must be ascertained; no reduction in weight will cause a velocity higher than 7 miles. The point remains; what is the relative value of the traction of the camel.

The averge load is 5 muns or 400 lbs. say 4 cwt, this increased by the ratio of the drawing to the carrying power of the horse, gives 9 cwt; or $\frac{1}{3}$ more than the horse, which in my opinion is near the truth, as each camel in the present experiment, drew that weight, without any reference to the weight of the rider or harness, 2 cwt. more; this average gives the value of the power of the camel in traction as 187 lbs. for low velocity, say $3\frac{1}{2}$ miles per

Digitized by Google

hour. Beyond 6 I doubt if any useful power could be obtained. Perhaps if led in hand at 2½ or 3 miles, the weight might be increased to 12 cwt. for baggage waggons. The Bullock is clearly made for slow traction; any great increase of velocity, is hardly obtainable to any useful purpose. Six hours, with a velocity of 2 miles may be taken as the standard; any increase beyond 4 may be considered as useless.

Duration.	Velocity.	Relative Value.	Actual Weight.
Constant to 6 hours.	2	93	4½ cwt.
	3	62	"
	4	0	"

Native carts may be seen on the road with 38 muns of grain, drawn by 6 bullocks, well fed and fine animals; 10 or 12 miles being the days march in 6 or 8 hours; giving 4½ cwt. per bullock, which is about the regulation allowance for a 9 pdr.

Bullocks of this description are fully equal to the carriage of 2 muns. The average calculation for Brinjaree droves, ill fed and of an inferior description, is 1½ mun, giving the ratio of the drawing to the carrying power, much the same as in the horse.

Having thus estimated the power, it may not be irrelevant to offer a few remarks on the other circumstances connected.

Food.

The inferior description of food on which the camel will subsist, is well known, and might on occasions point out the great propriety of using this animal for draught. But whether for this purpose, he may not require high and good feeding remains to be ascertained. The present Surwans place great reliance on mesaullah's, ghee, etc. of which the expense is great.

If fed on the system now followed, of 10 seers of bhoosah any 3 seers of gram, daily; the cost of actual feeding will be somewhat in favour of the single camel, compared with the single horse, taking the labour of the grass cutter, in the light of the bhoosah. In comparison with the single bullock, the expense

Digitized by Google

will be equal. The great advantage will consist in this, that fewer animals will perform more work. The decrease in the number of camp followers is not without its value.

Stable Attendance.

This point involves the question, how far are the Surwans of camels and drivers of bullocks to be looked upon as stable attendants. It is evident that the drivers of bullocks, and the riders of camels, render a less number of Artillerymen necessary for the service of the battery, as in the Horse Artillery, where Artillerymen perform the duties of drivers, hence only a portion of this expense can he charged, to the head of "Stable Attendance;" under any circumstances, some must be necessary, and as the pay of the Surwan is high, 7 Rupees; stable attendance may be fairly estimated at $\frac{2}{3}$ of that of the horse, whose syce is solely chargeable to this head.

Repairs of Harness.

From the simple nature of the harness and equipment, one-half of the allowance for the horse will fully answer. The medicine may be equal; the mesaullahs, if as necessary as now made out, will be a heavy item of expense. Stable appointments simple. The advantage will consist in the reduced number of animals.

Value of Life.

This is a question I have not the means fully to answer; but am informed, that camels are subject to several diseases, some of them fatal in termination; infectious to a degree, and unobserved in attack. They are not liable to galling; though equally with the horse to lameness. Some anxiety is usually expressed to the chance of chest lameness, if not warded off by the exhibit of mesaullahs, perhaps inflammation of the lungs from violent exertion.

The duration of horses in the Artillery, is certainly not above 9 years, when their age may be taken as 13, giving 8 years of efficient work.

The camel arrives at maturity at 5 years old, and is considered a much longer lived animal than the horse, but the rates of casualty

Digitized by Google

I do not know. He would certainly afford 8 years of efficient work.

The ratio of mortality in bullocks I do not know, he is fit for work at 4 and would perhaps give 6 years of efficient work.

Harness.

The first attempt in the camel, differs but little from that in use with the Horse Artillery, except in size. The new contrivance is simple in the extreme; and if found to answer, possesses many advantages; the heavy collar is reduced to the size of a harness breast strap, through a ring at the bottom of which the collar bar passes, but with this great advantage, that the ends, in place of resting on the neck of the animal are suspended to the bow of the saddle; and from its elevation all weight is taken off the neck of the animal, and every interference with the action of the shoulder obviated. It would be worthy the attempt; if some similar elevation could now be given to the bow of the Horse Artillery saddle.

The traction is from the body by a strong girth, ending as usual in the saddletree. The advantage of this with even two traces, is, that from the reduced length, the strain is unelastic, and constant, an advantage of some value, when it is remembered, that the numbers of pairs of horses being increased, from 2 to 4, reduces the power of the individual horse, from 6 to 4. It also gives 2 places for the application of traction, the side and the neck, in the event of either becoming galled. The point of attachment is near the centre of gravity of the animal, which is perhaps an advantage, considering that the body of the animal moves almost uniformly parallel to the surface, and not by the elevatiou of the fore-quarters as in the horse.

The line of traction is slightly upwards, considered the most favorable inclination.

With reference to the single trace from the body, and I had no opportunity to try double, it has in a greater degree the advantage of simplicity, and that it affords a third point for traction. But over the sand to Dadur, it did appear to me to cause some twisting of the body, not previously observed; it also caused the

Digitized by Google

wheel camels to exert themselves, perceptibly, more than those with long double traces from the shoulder.

The traction of the leaders from the pole, and shortness of all the traces, would prove a serious objection to quick turning or sharp Field exercise.

The cost of a set of harness complete, will not exceed 12 Rupees 8 Annas; the present Horse Artillery harness may be estimated at 25.

The saddle, jhool, and joodilah, will admit of considerable decrease in weight; and increase of appearance, but no diminution of cost.

Supply.

The mode of supply will naturally form an item of enquiry. In this respect the upper Provinces possess the facility for an equal supply of either animal, in cases of sudden demand; both bullock and camel have a superiority over the horse, as both are procurable without difficulty, while the supply of horses depends entirely on the studs, because these establishments have completely ruined the native dealer, and consequently diminished, almost annihilated the native breeder. The horse requires a much longer time to make him fit for harness, while I am told the camel takes to it with little or no trouble. Hansi, Dadree and Ihughur are famous for their breed of camels.

Application.

The horse is found almost in every country and climate, may be transported by ship, or boat; over every surface of country, level or mountainous, wet or dry; thrives equally well in hot or cold climates.

The camel is too high to admit of any useful transport by ship or boat, is considered the peculiar animal of a dry sandy soil; nor is the term "Ship of the desert" clothed with any unreal poetic metaphor. As yet our experience of the camel in traction, extends only to his own peculiar soil, at the

Digitized by Google

most favourable season of the year; whether he can draw equally well in mountainous districts, over sharp and flinty roads, remains to be tried. We have the best possible proof, that they will not live, much less thrive, in a damp or wet climate. Bad and narrow, roads materially affect his power.

Even the habits of the bullock is not so circumscribed as that of the camel; he can travel slowly but surely, over every surface of country, thrives equally well with the horse, suffering chiefly from extreme heat, which affects his powers of labor, more than those of the camel or horse.

The temper of the horse is generous, though not capable of much attachment; he can by kindness be rendered extremely tractable; can be urged on occasion, to a very high exertion of speed, and duration; is always of the same temper, and always ready for use. The camel is docile, but when "*must*" treacherous and unsafe; far too sluggish and lazy by nature, for excitement to any great pitch of speed or increase of power; nor can he suddenly, I fancy, be called upon for any great duration. Suwarree camels require constant training to be kept to their work. The camel is peculiarly quiet at work, moves well by night, surely, silently, but slowly.

The bullock is patient; but incapable of increase of exertion is soon knocked up, by any trifling addition to his average work, quiet at picket; and also moves well by night.

Proportional Estimate of the value, in traction, of the Horse and Bullock, compared with the Camel.

	Camel.	Horse.	Bullock.
Food	1	1¾	1
Stable Attendance	1	1⅓	½
Repairs of Harness, Medicine etc.	1	2	¼
Value of Life	1	0	0
Cost of Harness	1	2	⅛
Power at low velocity say 3½ or 4	1	1½	3
„ high velocity say 8	0	infinite	0
Application	1	½	⅔
Cost	1	5	⅓

Digitized by Google

Calculation of the Monthly Expense, of simply moving one Gun, and one Waggon, by Horse, Camel or Bullock Traction.

Horses 12...¼ Spare...18 Minimum	Rs.	A.	P.
Cost of 18 Horses, at 500 Rupees each, reduced to a rough Annuity, payable in 8 years	149	4	0
Food, 4½ seers of gram each, daily, at 40 seers..60 12 —...			
„ 8 grass cutters at 3 8 — per month.....63 — —...	123	12	0
Stable Attendance, 18 Syces at 4 8 —	81	—	—
Repairs of Harness, Medicine etc. at 4 — — per Horse.....	72	0	0
Cost of Harness at 25 — — per sett, reduced to a rough annuity for 8 years, the period it will last	7	4	0
Total Rups.	433	4	0

Camels 8...¼ Spare...10 Minimum	Rs.	A.	P.
Cost of 10 Camels, at 100 Rs. reduced to a rough annuity for 8 years	16	8	0
Food, 3 seers of gram each, daily, at 40 seers....25 — —...			
„ 10 „ bhoosah each daily at 4 muns....28 12 — ..	53	12	0
Stable Attendance ⅔ Horse, or 3 Rupees per Camel	30	0	0
Repairs of Harness, Medicine at ⅛ single horse	20	0	0
Harness at 12 8 — the sett, reduced to a rough annuity for 8 years	2	2	0
Total Rups.	122	6	0

Bullocks 16...¼ Spare...19 Minimum	Rs.	A.	P.
Cost of Bullocks, at 30 — — reduced to a rough annuity for 6 years	11	0	0
Food, 3 seers of gram each, daily, at 40 seers....42 12 —...			
„ 10 „ bhoosah each, daily at 4 muns....35 10 —...	78	6	0
Stable Allowance, ⅛ of Camel or 1 Rupee each	19	0	0
Repairs of Harness, Medicine etc. at ¼ Camel or 8 annas	9	8	0
Harness reduced to a rough annuity for 6 years	0	15	0
Total Rups.	118	13	0

These calculations may at first sight appear much against horse traction; but will be found no more than the direct ratio of their respective applications, which is the grand result that should govern every species of outlay, and is perhaps an illustration of the wisdom of Providence, which ever economical of its power, has seldom created two animals, with precisely the same powers and applicability.

The present trial, sufficiently proves that camels can be employed for traction, in favorable weather over sandy soils, the

Digitized by Google

very country, which prevailing opinion points to, as the side obnoxious to invasion.

Their application requires no alteration in the present gun or waggon carriage, simply a longer pole, with a supply of cheap and common harness. With these at a moment's warning, a battery of any desired calibre, could be quickly despatched from any magazine; with this further advantage, that at a slow pace, equal to that of Cavalry, very long marches might be made, and the artillerymen of the battery, brought to the field of action fresh, and capable of more effective service with their guns.

The experiment should perhaps be extended for some longer time, as continued labour and exertion, often bring to light defects, not apparent under limited experience.

Variations of road, weather and face of country, should be considered, with their combinations.

APPENDIX A.

Journal of March.

Date.	Place.	Time.	Distance.	Rate.	Remarks.
6 Nov.	Moondhuk.	° 4	13	3¼	Road round Delhi very sandy, intermixed with sharp and large stones, trying to the feet of camels; remainder of road, sand, in some of the hollows very deep; come the whole distance, without one halt over very heavy ground, the Artillerymen alighted; camels maintained one steady pace, and did not appear heated or distressed.
7th	Jukhowdah.	3½	10	3	Camels start without noise or confusion; one halt, occasioned by leading girth running back; a second after a heavy piece of ground near Bahadoorghur. I suspect the single trace will not answer, if camels become much drawn up on work. Road sandy and flat; animals not heated or distressed.

Digitized by Google

APPENDIX A.

Journal of March, continued.

Date.	Place.	Time.	Distance.	Rate.	Remarks.
8thNov	Khurawur.	4 1/5 0	15	3 3/6	Star light and cool; road sandy and flat, except a slight rise round Rohind, where one pole camel ran back a little; some little whip required; men got off the gun twice in heavy road. One camel slightly collar galled; but fault of collar.
9th	Khotuck.	2 1/2 1	10	4 1/3	Walked steadily for one hour, and then broke into slow trot, keeping up the pace till reaching the town. The animals move the guns with apparent ease, except over some heavy strips, which occasioned their breaking into a walk: some little urging from the whip appears called for, perhaps from the nature of the animal. Pole collar of the 9 pounder of the new pattern, with single trace outside; road firmer with less sand, little or no noise or rattle of chains.
10th	Khurkharah	1 1/1 0	15	3 1/5	Steady pace until Mudenah, here a slight rise and very deep sand, which brought the guns up for a moment. Artillerymen alighted when animals immediately collared.
11th	Mudahul.	4 1/1 0	14	3 1/2	Road sandy. Steady walk to Mohim, round which road very deep, a rather steep ascent beyond the town: brought the camels up until the Artillerymen alighted. Some whip required, no accident.
12th	Hansi.	4 1/2 0	14	3 1/9	Footing firmer and road somewhat harder; observe no difference in the traction, from the one or two traces. Steady pace. Increase of pace on hard strips of road very perceptible.

Digitized by Google

APPENDIX A.

Journal of March, continued,

Date.	Place.	Time.	Distance.	Rate.	Remarks.
20thNo.	Chotah Bowaney.	2.50	11 2/3	4	Clear of camp at ¼ before 6 ; wandering about among cuts of canal ; camels very patient among broken ground, walking with the cavalry, forced every now and then to break into trot to recover lost ground. Road hard and less sand.
21st	Bhurra Bowaney.	3.30	13	3¾	Road firm, but much cut up ; much time lost in winding round bushes. Trot 1½ miles before His Excellency. Keep up with cavalry, by an occasional trot. Infantry did not arrive for one hour.
22nd	Munhera.	2	7½	3 7/8	Road very sandy and winding round bushes, came on with cavalry. No accident, except breaking tail couplings.
23rd	Dadree.	2	8¼	4⅛	Road narrow, winding and deep sand, draught very heavy on animals, who appeared more distressed. The single traced camel did appear to strain and twist more than others, particularly the pole ones, cavalry beat us a little at end. One collar trace camel lame.
24th	Umlotah.	2.35	10¼	4	Road firmer and better. Camels came along with more evident ease than yesterday. Side trace takes more work out of animal, strain being constant and unelastic.
25th	Jhughur.	3,35	13½	3¾	Road firm but heavy from repair, rate slow as we were "in train." Camels took no notice of crowd near the town ; nothing disturbs them.
27th	Bupuny.	2.50	11¼	4	Road much as usual, but footing rather firmer ; kept up with the cavalry.

Digitized by Google

APPENDIX A.

Journal of March, continued.

Date.	Place.	Time.	Distance.	Rate.	Remarks.
28 Nov.	Bahadoor-gurh.	1.40	7	4 1/5	Road very bad, too narrow to admit of two camels abreast; one fell which created some delay, a good deal of whipping necessary to make up lost ground: sandy and winding.
29th	Mudeepore.	2.50	10 3/4	3 9/11	Road broad but very deep in sand, camels brought up once or twice to a stand, and laboured a good deal; Present load is a maximum. Single trace certainly took more out of pole animal. Cavalry beat us by 10 1/4 minutes.
30th	Delhi.	2	7 1/4	3 5/8	Road sandy and heavy, intermixed with stones and bricks. Kept up well with cavalry, being in train of His Excellency.

APPENDIX B.

Measurement.

			feet.	in.
Height of camel 21 hands or			7	1
From head to point of shoulder	3	10		
" Shoulder to point of rump	5	8		
Total space occupied	9	6	9	6
From head of leading camel	12	6		
" Pole to Splinter bar	8	10		
" Splinter bar to muzzle of gun	14	10		
Total space occupied by gun and camel	36	2	36	2
Length of rear Trace side			5	1
" " " collar			7	2
" leading " side			6	5

Digitized by Google

APPENDIX B.

Weights.

Weights.				st.	lb.	oz.
Golundauze in Military dress with sword				9	4	5
Serwan in undress				8	2	10
Trace with chain	lbs.	12	0			
Breeching	„	7	10			
Collar	„	21	5			
Pad, Rope, Gudalah	„	13	5			
Saddle	„	46	5			
Whip	„	0	12			
Total complete..lbs		106	0 or	7	8	0
Weight of a 24 pdr. howitzer complete				32	cwt.	
New Harness.						
Collar strap				0	9	2
Trace				0	3	0
Girth				0	9	1

Letter No. 44, *from Major General* J. R. LUMLEY, *Adjutant General of the Army, dated Head Quarters, 25th January* 1838, *to Major General Sir* W. CASEMENT, K. C. B., *Secretary to the Right Honorable the Governor General of India, Military Department.*

With reference to the Letter, which I had the honor to address to you, on the 19th ultimo, on the subject of experiments, which have been recently made, in adapting camel draught to ordnance; I have been instructed, by His Excellency the Commander-in-Chief, to forward for the information of the Right Honorable the Governor General, and for such further notice as His Lordship may think fit to order; a letter in original to my address under date the 10th instant, from Major P. L. Pew, together with a journal of his march from Delhi to Ajmere, with a 9 pdr. gun drawn by camels.

Letter from Major P. L. PEW, *Commanding 2nd Battalion Artillery, dated Nusseerabad, 10th January* 1838, *to Major General* J. R. LUMLEY, *Adjutant General of the Army.*

For the information of his Excellency the Commander-in-Chief,

Digitized by Google

I have the honor to forward a Journal of my march from Delhi to Nusseerabad, with the 9 pounder gun drawn by camels—The entire distance 244 miles was performed in 15 marches; but had fodder been procurable and I not kept back by bullock hackeries the greater part of the way, it would have been done in seven, notwithstanding the badness of the road, which is, probably, the most sandy and heavy one in India. The camels did their work most admirably, and though without fodder they fell not off in flesh, nor were they at all fatigued by the march down.

I tried all kinds of harness, and endeavoured, but unsuccesfully to gall them with *collars*. None of them were in the slightest degree galled, altho' my own three *buggy* horses, pulling in turn an *empty buggy* were badly so, by the time I reached Kurrunsir, 168 miles from Delhi.

Major Pew's *March from Delhi to Nusseerabad, with a 9 Pdr. Gun drawn by Camels.*

Nusseerabad, 31*st December*, 1837.

Marched from my house at Delhi on the 14th of December 1837, to Sohul-ke-Sarai 15 miles, with the 9 pounder drawn by two camels and 6 camel carts by way of experiment—Road bad and stony—Broke one of the cart axletrees. On reaching the encamping ground, sent back the two camels of the cart with the broken axle to Delhi for a fresh cart.

15*th December*.—To Hursooke Garre 13 miles.—First part of the road good, latter part very sandy and heavy—encamped on the sand hills. The fresh cart from Delhi came up here at 11 o'clock A. M. The two camels quite fresh, although they had, firstly dragged a loaded cart to Sohul-ke-Sarai 15 miles—secondly, returned to Delhi 15 miles—thirdly, brought up a cart to Sohul-ke-Sarai 15 miles, where they took up the load of the broken cart and came on to Hursooke Garre, 13 miles; having in all, gone 58 miles within 28 hours.

N. B. No fodder procurable—fed the camels on 5 seer of gram each.

16*th December*.—To Patoode 13 miles—Road very sandy and

Digitized by Google

heavy the whole way—No fodder procurable—fed the camels as yesterday.

17*th December*.—To Kewarrie 14 miles.—Road heavy and sandy nearly the whole way, tho' not so bad as yesterday.—A pole of one of the carts broke to-day owing to a knot in the wood—no fodder.

18*th December*.—Halted to make a new pole, and entertain some bullock hackeries to carry my servants' families and their baggage.

19*th December*.—To Shahjehanpore 16 miles.—Road much better to-day, tho' the first 3 miles were sandy. No fodder.

20*th December*—To Goojurbus 18 miles.—Road sandy in parts, passed the deep sandy bed of a river, 1 mile in extent. The bullock hackeries which started 2 hours before the gun, though carrying only half the usual load, and assisted by numerous servants did not reach camp until 3 hours after the gun's arrival. A difference in speed of 5 hours in 18 miles. No fodder.

21*st December*.—To Prangpore 18¼ miles. Road as far as Kutpootee (10¼ miles) good, but there deep in sand, and sandy all the way thence to Prangpore. Considering that the camels had had no fodder since leaving Delhi, and that one single pair (never changed) had already brought the gun nearly half way to Nusseerabad, I deemed it unnecessary to tax their powers to the utmost any farther, and I accordingly towards the close of to-day's march, hooked on a couple of leaders to the gun, and resolved on so doing in future, whenever the road should prove heavy or sandy. The bullock hackeries, which started 2 hours before the gun, did not reach camp till 6¼ hours after it No fodder procurable.

22*nd December*.—To Bhowbra 11¼ miles. Four first miles very sandy, afterwards better, tho' sandy at times. The bullock hackeries which started with the gun to-day did not come up till 4¼ hours after it. No fodder.

23*d December*.—To Munnohurpore 13¼ miles. Road very deep in sand the first three miles, and for the next two miles deep, tho' less so than the first 3. Latter part of the march very bad again. The bullock hackeries which started with the gun, came up 6 hours after it. No fodder.

Digitized by Google

21th December.—To Samote 11 miles. First part of the road very deep in sand, and gradually rising to the Pass, between low hills, where it is unusually heavy in sand. A short steep sandy ascent leads to the top of the Pass, after which altho' sandy for 3 miles the road becomes much more easy, tho' generally of a difficult nature. The pull from the last ground to the top of the Pass was a trying one. I had to hook on camels as leaders to the bullock hackeries; which tho' lightly loaded, and assisted by camels to the top of the Pass, did not reach camp till 4 hours after the arrival of the gun; notwithstanding that they had started two hours before it. No fodder. Rain in the evening and as the weather looked threatening I ordered a halt to-morrow.

25th December.—Halted Samote. No fodder.

26th December.—Hearing that there lay some very heavy sands immediately in our front, and which it would be extremely difficult to clear in the dark. [there being now no moon in the morning] I moved the camp across them last evening, and came on to-day to Kurrunsir 24¼ miles, according to the Quarter Master General's route, but instead of 24¼ miles only, the guides having taken us from village to village in the dark, by way of getting themselves speedily relieved, we lost the road and had to find our way to camp by footpaths and deep sandy fields, which must have added some 6 miles to our route, so that the actual distance travelled was about 30¼ miles; two-thirds of which was through the deepest sand.

This was one of the most trying marches for draught animals I ever met with, and the camels performed it nobly, the last 10 miles, one continued pull through deep sand without an interval of hard ground. The bullock hackeries, which started at 2 A. M (2½ hours before the gun) did not reach camp till 6¼ P. M. and then so completely knocked up, that I ordered them and part of my camp to halt the following day, and to come on afterwards by the usual short stages. My camel carts up to this place, where I left them for the sake of the guards' protection, had invariably kept pace with the gun, since leaving Delhi.

27th December.—To Jobneer 10 miles; first 5 of which very deep in sand, road afterwards lighter and better.

Digitized by Google

28th December.—To Sahowrah 17¼ miles, first 3 miles heavy sand, next 3 lighter—then again sand for 6 miles, but first part of this only heavy.

29th December.—To Kchlana 15¼ miles, very good, some sandy gravel at Doodir and other places, came in cleverly.

30th. To Nusseerabad, 33¼ miles: marched at 2 A. M. to Hurrah 16¼ miles *at a walk*, then at sunrise *trotted* the remaining 17 into Nusseerabad, where the gun arrived at ¼ past 9 A. M., the camels not in the least fatigued, nor were any of them in the slightest degree galled by the harness during the march down from Delhi.

Letter No. 82, from Major General J. R. LUMLEY, *Adjutant General of the Army, dated Head Quarters, Simla, 14th February* 1838, *to Major General Sir* W. CASEMENT, K. C. B., *Secretary to the Government of India, Military Department.*

I am instructed by His Excellency the Commander-in-Chief, to request that my Letter No. 60, of the 3d Instant, may be placed before the Right Hon'ble the Governor General, and reference be made to the 14th paragraph of the same.

As connected with that paragraph, His Excellency directs me to say, that he submitted questions (as in the accompanying paper A) to Captain Anderson, of the Horse Artillery, who was in charge of the guns and camels during the march heretofore detailed; and as the answers to these questions convey useful information; I am directed to transmit the same to be attached to my letter first referred to.

A.

What was the cost of feeding the 15 camels which accompanied the 2 guns and carriages, with the Commander-in-Chief, this autumn from Delhi until their return to that place?	Gram 4 seers each	106,, 1 5 ,,
	Bhoosah 10 ,, ,,	76,,14 ,,
	Ghee, Mesaulah	15,,15 ,,
	Grinding gram	4,,— ,,
	Total..	203,,12 ,,

Digitized by Google

For how many days, supposing the same guns had been equipped with the ordinary number of bullocks, and had been marching the same number of days, what would have been the cost of feeding those bullocks?	41 Days from 1st Nov. to 11th of Dec. 28 bullocks. Gram 3 seers each. 149,,11 ,, Bhoosah 7 ,, ,, 100,, 7 ,, Salt Mesaulah 3,,10 ,, Gram grinding 4,,— ,, Total..257,,12 ,,
The cost of the persons who collect the food to be included in each instance.	Would all be paid by the Commissariat. No Establishment allowed for the purpose. I obtained it by my own people from bazars.

MEMORANDUM.

The camels therefore cost less than bullocks would have cost by nearly ¼, and I am doubtful whether the bullocks would have been capable of performing the march with the Infantry.

(Signed) H. FANE,
General.

14*th February* 1838.

STATEMENT *shewing the number of Men and Animals required for equipping the Experiment Battery at Delhi, under the scrutiny of Major* PEW.

DELHI, 3D APRIL 1838.

1 Captain.	
2 First Lieutenants.	
1 Second ,,	
1 Subadar.....	Golundauze.
2 Jemadars.....	
1 Brigade Havildar...	
5 Havildars.....	
6 Naicks.....	
2 Buglers	
48 Privates.....	
1 Hand Bheestie.....	
1 Tent Lascar.....	

Digitized by Google

3 Sirdar Sowars.....
54 Camel do. .... } Driver Company.
1 Bheestie..... ....

1 Maistry Smith.
2 Filemen.
2 Forgemen.
1 Hammerman.
1 Maistry Carpenter.
2 Workmen do.
63 Bhagree camels from 5 to 8 years of age.
5 9-Pounder Guns.
1 24 „ Howitzer.
6 Waggons.
1 Artificer's Cart.

(Signed) P. L. Pew, Major,
On Special Duty at Delhi.

Digitized by Google

LIGHTNING CONDUCTORS FOR POWDER MAGAZINES

Letter No. 54 of 1841, from the Hon'ble the Court of Directors, dated London 23d June, to the Governor of Bengal, being a reply to letter No. 39, of 1841, dated 17th March, transmitting further papers, on the subject of providing Lightning Conductors to Magazines.

1. "These papers together with those transmitted by the Government of Bombay with their Military letter of the 21st January 1841, No. 5, having been laid by us, before Professors Faraday, and Daniell, we have been furnished with their sentiments on the subject in letters, of which copies are herewith enclosed."

2. "As these scientific individuals adhere decidedly to the opinion formerly given by them in favor of attaching lightning conductors to Powder Magazines, we have resolved in conformity, with your suggestion, to provide a supply of copper rods, of the required diameter, viz: one inch, for the purpose of being used as conductors to the several Powder Magazines in India, according to the plan recommended by Mr. Faraday."

Letter from Professor J. F. DANIELL, *dated King's College, 10th May* 1841, *to* P. MELVILLE, *Esq. Secretary Military Department.*

"According to the directions contained in your note of the 19th ultimo, I have read and carefully considered the collection of papers which you have transmitted to me, regarding the subject of lightning conductors, and have now the honor to submit the following remarks for the consideration of the Chairman, and Deputy Chairman of the Court of Directors."

"I regret extremely that Dr. O'Shaughnessy should have been angered by my report of the 24th August 1839, and that in his second report of the 24th June 1840, he should have indulged himself in a tone of asperity towards me, which is as unnecessary as it is unusual, in such communications. I have turned with some anxiety to my report, to see if any expression had dropped from me, which could fairly be interpreted as inconsistent with

Digitized by Google

that respect which I had always entertained for his character, and abilities, and am happy to say I cannot reproach myself with any such inadvertence. I felt, indeed, at the time, that the urgency of the case required that I should express the strongest dissent from the conclusions at which Dr. O'Shaughnessy had arrived, but nothing was further from my intention then, or is now, than any departure from that courtesy which ought especially to prevail in scientific discussions."

"I am happy to observe, that the wide variance of Dr. O'Shaughnessy's opinion, with mine, which he announces will practically be of very little importance, in as much as he states himself to differ in but a slight degree from the opinions of Mr. Faraday."

"Dr. Faraday commences his report in the following words, "my "opinion is in favor of lightning conductors" and he concludes as follows. "In my opinion a good conductor, well connect- "ed with the earth, cannot do harm to a building under its pro- "tection, i. e., though it may induce a discharge upon itself, it "cannot induce a discharge upon the building, and the discharge "in itself cannot give rise to any secondary effects which are "likely to place the building in more danger, than it would have "been subject to, had the conductor not been there."

"How Dr. O'Shaughnessy reconciles "within a slight degree" this decided opinion in favor of conductors with his own, is not of so much consequence, as that he should act upon the decision to which he professes to defer."

"The danger of delay is again apparent from the explosion in June last, of the corning house at the powder works at Mazagon, by a stroke of lightning, the building unprovided with any conductor; with regard to this, as with the similar explosion at Dum Dum, Dr. O'Shaughnessy would probably draw a distinction between the building, and a properly constructed Magazine, arched and rounded, and in its outlines of low elevation; but granting that the danger is greater in proportion to the elevation of the buildings, I cannot admit that such buildings are exempt from danger, or that the question of erecting conductors near them, is altogether different from that of attaching conductors to private dwellings or ordinary

Digitized by Google

buildings. In the grand system of natural operations carried on in a thunderstorm, even considerable elevations bear little proportion to the enormous surfaces which are brought under induction, and do not influence the discharge to any great extent; in proof of which, the lightning has often been seen to strike the level of the sea even in the vicinity of high masts of ships armed with conductors. It is true, that the chances of a low building, or of an equal area of soil or terrace being struck are small, but what prudent man would run even this small risk where the stake is so serious and the cost of insurance so slight."

"Dr. O'Shaughnessy seems disposed to admit, that safety may be given to a building from direct and ordinary discharges by conductors " erected in such a way that no point of the roof shall " be further from the conductor than twice the length of the " height of the conductor above the level of the roof," but he adds; " this applies only to flashes from clouds in a calm atmos- " phere and above the building, the area of protection is unques- " tionably much contracted under the circumstances so common " in India, of a thunder cloud being blown with hurricane velo- " city across a plain before a furious storm."

" This distinction I am quite at a loss to understand. I will not suppose that Dr. O'Shaughnessy means to compare the velocity of lightning with that of the most furious squall that ever blew; or that he wishes it to be inferred, that the latter could have the slightest influence upon the former. If as we have every reason to believe, lightning travels with something more than the velocity of light, its transit between the cloud and the earth must be completed in an inappreciable moment of time, and whether in a calm atmosphere or in a hurricane, its direction will be that of least resistance at the single moment in which the discharge is at once commenced and completed. The object of the lightning rod, is to present a course of less resistance than that of the object which it is meant to protect. No paroxysmal storm (if I understand the term) would have power to cause it to deviate from this course. Dr. O'Shaughnessy has strangely misunderstood my words, which he quotes in the margin of his second report, and makes great use of the misconception; he says, " Mr. Daniell has indeed stated

Digitized by Google

" that a pointed bar must cause a silent discharge without explo-
" sion." I am quite sure that if he will take the trouble to repe-
ruse the paragraph, he will be candid enough to allow, that I have stated no such thing."

" I have said that a pointed conductor will draw off silently and safely, a considerable portion of electricity from a charged cloud, but it can possess no power of determining a disruptive and destructive discharge at a point where it would not otherwise occur.*

At points where it would otherwise occur, of course the discharge would take place, and I am not indeed surprised that Dr. O'Shaughnessy should be unable to comprehend how Mr. Daniell could have fallen into such a misconception."

" Upon reconsideration, I trust that he will allow that there is no immediate necessity for my repeating the very *simple experiment* which he has done me the favor to suggest; I entirely agree with him, that it is quite essential that no misconception should arise, and I freely admit what I have never dreamt of denying, that an explosion may occur to a pointed conductor; what I deny is, that if the conductor be properly constructed, any injury will arise to a neighbouring building from such an explosion."

" In the next point I fear I have the misfortune to differ again very materially from Dr. O'Shaughnessy, he undertakes to shew, that the quantity of the electricity passing, may be so much greater in quantity than the single conductor can convey *in the time* of the discharge, that a considerable part, nay the whole of the excess, must pass to the adjacent objects. Now the only measure of the capability of a conductor to convey a discharge, is its capability of resisting fusion. If it be fused by the discharge, a considerable part I admit, must pass to the surrounding objects. Even in the case of non-fusion, I have no doubt that a small portion would pass through a small interval of air from the main conductor to another good conductor placed at a very short distance from it. The charge would divide itself upon the two conductors in proportion to the facilities of transit, which the two passages would

* I of course mean without the small circle of protection, within that circle it has the power of determining the discharge upon itself, rather than upon other parts.

Digitized by Google

offer, including of course the high resistance of the interval of air through which it must leap. But one of the obvious precautions in erecting a lightning rod, is to place it at a great distance from any such good conductor."

"The instance adduced from Mr. Arago's collection, of Mr. Raven's house in Carolina, is an example of an insufficient conductor being melted, and of the consequent passage of the excess to a conductor in the neighbourhood. The accident to Dr. Goodeve's house upon which Dr. O'Shaughnessy has laid so much stress, would not have proved the contrary even had the distance between it and Mr. Trower's conductor been only 20 feet, as originally stated. The distance of 66 feet, which has since been ascertained as the true distance between them, placed the house beyond the protection of the conductor according to M. Biot's opinion, which Dr. O'Shaughnessy deemed the case *completely to falsify*. Dr. O'Shaughnessy must now himself allow, that this could not be an instance of lateral deviation from a conductor. In acknowledging this great mistake in his letter of the 11th September 1840, Dr. O'Shaughnessy refers to me, in terms so unusual either in official or scientific communications, that I shall refrain from further comment, only assuring him, that he greatly mistakes my spirit, and that so far from triumphing in the overthrow of this main fact, upon which he has founded so long an argument, I am even now disposed to grieve at the unnecessary acuteness of his feelings upon the occasion."

"In discussing however the question, what is the greatest mass of metal, a flash of lightning can fuze, Dr. O'Shaughnessy has mistaken the law of the distribution of *statical electricity* upon the surface of bodies, for the law of the conduction of *current electricity* through them. Nothing is more certain, and nothing more generally admitted by all competent authorities upon the subject, than that the conducting power of all bodies is *cæteris paribus*, directly as the area of the section through which the electricity passes. I believe that Dr. O'Shaughnessy would find it difficult to produce *one fact* which shews it to be "the surface which the electricity pursues."

"It is this fundamental error, which has led him to imagine, that

Digitized by Google

the surface of a conductor may be inadequate to convey a quantity of electricity, although this be insufficient to melt or even to heat the whole length of the " metal."

" Dr. O'Shaughnessy's observations upon the power of conductors to attract lightning, being only personal to myself, the public service does not require that I should notice them, and I shall therefore willingly pass them by with one remark, viz: that " drawing " off silently and safely a considerable portion of electricity from " a charged cloud," and, " attracting a flash of lightning" are *not* very like synonymous terms as he asserts them to be."

" With regard to the dangers to be apprehended from a *lateral discharge*, I have no expectation of converting Dr. O'Shaughnessy to my unchanged opinion, that with properly constructed conductors, there is nothing to be apprehended from it, but the matter has been so fully discussed by the most eminent electricians, that I think the court will have no difficulty in coming to a correct conclusion without attaching any particular importance to our unanimity upon a subject. The deliberate opinions of Dr. Faraday and Professor Wheatstone, with the reasons of their conclusions upon the subject, are fully recorded in the report of the Committee upon lightning conductors, which was in the possession of Dr. O'Shaughnessy at the time of writing his last report, and to that I have nothing to add."

" As however Dr.O'Shaughnessy has selected " an experiment with " the leyden bottle to exemplify his statement," and illustrated it with two diagrams, and as from his so doing it might be inferred, that he supposes that it has escaped the attention of Dr. Faraday and Professor Wheatstone, as well as of the Committee who made the report; although, as he states, " all electricians have seen it, " and *the existence of the spark* is *universally admitted*;" I think that I cannot be excused from giving at length the grounds of my opinion that he has totally misunderstood the results of this common experiment."

" Upon comparing Dr.O'Shaughnessy's diagrams with the directions he has given for conducting the experiment, it will be obvious that he has omitted one part of the apparatus in use, by increasing the mass of which " as he very properly states," the success of each attempt at obtaining the lateral spark will increase viz: the *prime*

Digitized by Google

conductor: from this it appears, that he supposes his jar in contact with the prime conductor, and the diagram should have been of this kind,—fig. 31."

"Here *A* represents the prime conductor, now when this system of bodies is under charge, we can distinguish it into two portions, the main charge which is sustained by the glass placed between the metallic coatings of the jar, and a secondary charge, which is sustained by the air which is interposed between the prime conductor and surrounding objects, of which the metallic ball *C* is one, the ball *C* is in the opposite state with regard to *A*, just as the outside coating of the jar is, with regard to its inside coating. Upon the application of the discharging rod two simultaneous discharges take place; the main discharge, which is incomparably the greatest, which neutralizes the two electricities upon the opposite sides of the jar; and a secondary discharge, which places the prime conductor *A* in equilibro with *C* and other objects with which it is in communication. This secondary discharge will therefore obviously be proportioned to the size of the prime conductor, as Dr. O'Shaughnessy correctly states, and independent of the prime conductor itself, a very small portion of free charge, as it has been called, or charge sustained by the air to surrounding objects, will always be found upon one or other surface of a charged jar, from which a wire and ball projects, as usual, beyond the coating."

"The circumstances however of an atmospheric charge, can never resemble those of the arrangement I have been endeavouring to explain, and the conditions of a thunder cloud and an equal area of the earth's surface with the interposed air, are exactly similar to the coatings of the jar and their interposed glass *alone*, without the possibility of any associated system of bodies at all resembling the prime conductor and the ball, such a secondary spark as that adduced by Dr. O'Shaughnessy could not therefore occur."

"Dr. O'Shaughnessy may possibly consider this explanation of "an experiment which all electricians have seen," as a successful application of my "ingenuity in placing the question in a less intelligible point of view," but it is nevertheless one that has frequetly been given by the first electricans, and is indeed obvious.

Digitized by Google

" In adverting to Mr. Snow Harris's conductors for ships, it is much to be regretted that Dr. O'Shaughnessy should not have referred to the evidence of facts, derived " from the experience of many years which proves the efficacy" of his plan. It is fully detailed in the report of the Committee, and Dr. Faraday observes, that he " could not but appeal to the evidence " of experience, ships fitted with his conductors had been ex- " posed to severe lightning, and the *electricity had been known* " *to descend by them* with perfect security to every thing on " board, nor was there, so far as he could learn, any instance on " record of lateral explosion."

" With this evidence before him, it is scarcely to be conceived that Dr. O Shaughnessy could have expressed a wish, that " his " humble voice could reach the Lords of the Admiralty" in disparagement of them, or that he should have ventured to insinuate, that they were advocated by men who had " other than pub- " lic interest," at heart, and pledged " scientific notions to " maintain."

" I think that it would be a useless occupation of your time, to enter upon any further discussion of Dr. O'Shaughnessy's opinions. The evidence is so complete as published in the several reports upon the subject, that without regarding any difference of opinion between Dr. O'Shaughnessy and myself, the Chairman and Deputy Chairman and Court, can have no difficulty in coming to a right decision upon this important question; and when I recollect that the efficacy and safety of lightning conductors has been maintained from the time of Franklin, to our own times, by such men as Passon, Dulong, Gay, Lussac, Davy, Wollaston, Arago, Faraday, Wheatstone, and Snow Harris, and that no fact has been substantiated of any damage having arisen from such conductors of proper construction, either from lateral explosion, or otherwise, all asserted instances to the contrary having invariably, like the accident to Dr. Goodeve's house, been disproved upon proper investigation. I cannot doubt that decision will be to direct the careful erection of sufficient conductors to all the Magazines, of powder throughout the Company's dominions."

Digitized by Google

"I need scarcely assure you, that should the Chairman or Deputy Chairman, desire any further explanation upon the subject, it will give me the greatest pleasure to afford it, to the best of my ability, either personally, or in writing, as they may require."

P. S. "In a letter from the Military Board to the Governor in Council, I observe that a question is submitted as to the case of a Magazine situated upon a rock, to which I have no hesitation in replying that if a perfect communication were made, between the conductors and the water in the excavated reservoir, the provision would be quite sufficient for carrying off the electric fluid."

Letter from Professor J. F. DANIELL, *dated King's College, London, 15th June* 1841, *to* P. MELVILLE, *Esq. Secretary Military Department.*

"I have looked over and attentivelyconsidered, the additional collection of papers upon lightning conductors, dated Bengal, 17th March 1841—which you have done me the honor to transmit, and have found nothing to induce me to alter my report of the 10th May."

"In Dr. O'Shaughnessy's letter to Major De Bude of the 30th December 1840, he insists more strongly than ever, "that every "fact in the history of lightning shews it to be *surface* of conduc-"tors and not *mass* which is required for the safe conveyance of "the electric discharge."

"This I have already pointed out as a fundamental error, which affects most of his reasoning upon the subject. If there is one law of electricity better established than any other, it is, that the conducting power of all bodies is directly as the square of the diameter of cylindrical rods, or as the area of the section whatever the form may be."

"In erecting lightning conductors, it would be a fatal mistake to rely upon the surface without regard to the thickness of the metal."

Digitized by Google

Letter from Professor W. FARADAY, *dated King's College, London, 9th June* 1841, *to* P. MELVILLE, *Esq. Secretary Military Department.*

"I have received your letter of the 3rd instant, and also from M.r Daniell the various papers it refers to; I have reperused Dr. O'Shaughnessy's first papers and my report of the date of 5th September 1839, and have now read Mr. Daniell's report of the 24th August 1839, and Dr. O'Shaughnessy's further communications and remarks. These with the other papers, I have carefully considered, and as the general result, beg to say that I see no reason to alter even a word of my former report."

"In saying so much, perhaps I say every thing that the Hon'ble Court of Directors, desire of me, for it is probably more the judgment of the individual, than the reasons for the judgment that is required. The latter it is almost impossible for any man to give fully, in a case where there are arguments and reasons on both sides of a question, for the bearings of these become almost infinite in number, by reason of the variation in degree of force which they possess under varying circumstances; and at last, it is the discretion, experience, tact and caution of the person which give to his opinion any worth, it may, in reality, possess."

"But as the present is a question which is referred back to me, I ought perhaps, not to think it one in which the mere opinion, without reasons will suffice, and yet I find a difficulty in going further into the matter, for seeing and deeply regretting a particular tone and character which some parts of the communications have acquired, I am exceedingly anxious to keep myself quite clear from it, and may perhaps find this rather difficult. However, in what I may further say, I shall avoid referring to the opinions I agree with, or differ from, as much as I can; yet without withholding my own opinion on any of the important points which are essential to the case, and are intended by the Court to be submitted to me."

"There are I think three points under which all that is for consideration may be arranged."

Digitized by Google

1st. *Whether a good lightning conductor can cause a discharge, where there would not be one otherwise.*

2nd. *Whether when the electric fluid falls upon a conductor, a part may not pass from it in the form of lateral discharge and occasion harm.*

3rd. *Whether at the moment the lightning conductor is struck, it may, by induction upon the gunpowder casks lined with copper, or other metallic masses within the Magazine, cause sparks to pass between them without any actual lateral passage of lightning from the conductor.*

As to the first; I have already said that I think a good conductor, may under certain circumstances cause an electric discharge to take place where otherwise there might not be one, that in fact it can virtually attract the lightning. It is to this quality that it owes much of its usefulness if it have any; for unless it could divert the discharge (within certain limits) from a place where the lightning would otherwise have fallen, the conductor would have no use. But that it should cause a discharge upon itself, and also at the same time upon a neighbouring object, as in the given case of Dr. Goodeve's house, and that not by a lateral discharge, is what I see no reason to expect either from principle, my experience, or such events as have come to my knowledge.

It is said that Dr. Goodeve saw the flash divide, part going to his own house *in the verandah of which he stood*, and part to the lightning conductor of the neighbouring house. When flashes occur so close to, and over a person taken at unawares as in this case, it is exceedingly difficult to distinguish exactly what takes place as to the direction of the electric flash, for there are many remarkable and confusing effects that simultaneously occur; still, admitting the division, I cannot but think the conductor acted as it ought to do rather than as it ought not, and that there would have been a much heavier explosion on Dr. Goodeve's house if the condutor had not in part averted it, though at the distance of 60 feet, than did occur under the existing circumstances.

2d. The most important point however, is, *whether when the electric fluid falls upon a conductor, a part may not pass from it in the form of lateral discharge and thus cause harm.* Before I make

Digitized by Google

further remark upon this head, I must repeat the words I used in my former report, "I have no fear of lateral discharge from "a *well arranged* conductor. As far as I understand lateral "discharge, it is always a discharge from the conductor itself. "It might be very serious from a badly arranged conductor (and "in fact makes them worse than nothing) but with a good light- "ning rod it can be but small, and then not to badly conducting "matter as wood or stone, but only to neighbouring masses of "good conducting matter, as the metals which, either ought not "to be there, or if they are necessarily present, ought to be in "metallic communication with the lightning conductor itself. I "am not aware that lateral discharge can take place within a "building when a lightning conductor outside is struck, except "there be portions of metals as bellwires, bolts &c., which "may form an interrupted conducting train from the conductor "to the interior."

That a lightning conductor well arranged as to its termination with the earth, especially if not of sufficient thickness, may give lateral discharge in the form of brushes and sparks, even when the quantity of electricity passing through it is not a thousandth part of that required for its fusion, or which the conductor could safely convey if alone, I can well believe and understand; but for this to happen, it requires an arrangement which I have already protested against above, the effect when it does occur is due to the resistance which even the best conductor makes to the passage of the electric fluid, and will be understood if I briefly describe a few experiments which I have made for my own satisfaction. We cannot always it is true, say that our apparatus accurately represent natural circumstances; for the two sides of a Leyden jar do not correctly resemble the state of a cloud and the earth, the conducting power and aggregation of the charged surfaces are different, and so is the state of the medium between them, but the general principles are the same. In these experiments I used the mere spark of a large and good machine, employing no Leyden jar. fig 32.

A is the knob of a large prime conductor, *B* a metallic ball 6 inches in diameter, the distance from it to *A* being variable between the limits of 4 and 10 inches, *C* and *D* were wires of copper 40 feet in length, and each well connected at one of their ends with a

Digitized by Google

large and extensive series of water-pipes *W*, one of them was $\frac{1}{20}$ of an inch in diameter and the other $\frac{1}{10}$ of an inch.

When either of these was connected with the ball *B*, and electric sparks passed from *A* to *B*, the electricity was conducted away perfectly by the wire, but when the end of the other *D*, was brought to within a small distance of *C* in any part between *E* and *B*, a lateral spark passed from the conducting wire to the approximated wire at the same time that the principal spark passed from *A* to *B*. The lateral spark was brighter and larger according as the part of the conducting wire from which it was obtained, was nearer to the ball *B*—and further from the water pipe, and this is an important point, for the water pipe here represents the earth in a well arranged lightning conductor; when the wire *D* was taken off from the water pipe, and made fast to another set of pipes as its final discharge, still the same effects occurred. When a person standing on the carpet of the room tried to draw this lateral spark from *C*, by approximating the knuckle, he could scarcely obtain any traces unless he held the wire *D* in his hand, and then the badly conducting matter of his hand could draw a very feeble spark. This lateral spark was still more beautifully shewn to depend upon the resistance of the matter of the wire, by taking a piece of wire *O*, about 10 or 12 feet long, and making it fast on to *C* at *E*, and then bringing the other end near, at some part towards *B* as at *H*, for a lateral spark passed at *H* shewing a certain division of the discharge through the two wires C and *O*. When a similar wire *M* was brought near to the wire *C* at *K* and at *I*, not being in contact at either place, then every time the lightning flash passed between *A* and *B*, a small spark passed from the principal to the secondary wire at *I*, and one from the latter back to the former at *K*; to complete this kind of observation, the single wire *C* was removed, and replaced by a bundle of five parallel wires well connected at the two ends, and as their respective diameters were $\frac{1}{10}$ $\frac{1}{8}$ $\frac{1}{6}$ $\frac{1}{5}$ $\frac{1}{4}$ of an inch, they were together equal to a copper rod above one-third of an inch in diameter, and 40 feet long, representing not unaptly a lightning rod of small thickness, still when the flash passed between *A* and *B*, lateral sparks could be obtained from any or all of these wires at the parts towards the ball *B*.

Digitized by Google

I changed the discharger *C*, which represents the lightning conductor, and made it to consist of a fine copper wire only $\frac{1}{4}\frac{1}{2}$ of an inch in diameter: the same general effects were obtained, the lateral spark being however longer than before. I made the lightning distance from *A* to *B* vary from 8 inches to 2 inches, and took the lateral spark continually from a certain spot near *B*, i. e about 6 feet from it. The lateral spark was nearly half an inch long, and quite as long for the two inch lightning spark as for the 4 inch or 8 inch lightning spark, a result dependant on the circumstance that the 2 inch spark though containing less electricity is a quicker spark than the 8 inch or longer one, *time* being here concerned in a manner evident to an electrician.

I also made the lightning distance a constant interval of $\frac{1}{4}$ of an inch, and then compared the effects of small sparks from the conductor only, with those of a denser spark of a larger jar, to illustrate the influence of quantity. The lateral spark was the same length in both cases, but much brighter when the jar was used than when only the conductor spark was employed. In all these experiments with the fine wire *C*, an excellent discharger was used for *D*, (being a wire $\frac{1}{4}$ of an inch in diameter) for the purpose of exalting the effects.

That these lateral discharges were really due to the cause I have assigned namely, the resistance in the metal to the passage of the electric fluid, and not to induction directly from the machine, was shewn by the following arrangement; a part of the wire about *I*, was completely sheltered from the effect of the machine by large uninsulated metallic plates, and yet the lateral spark could be obtained, though not so bright as when the plates were away. In the latter case, induction *acting* on the return discharge was combined with the lateral discharge.

Here then are lateral discharges, and occasionally from a rod 40 feet in length, equal to $\frac{1}{4}$ of an inch in diameter, well connected with a discharging system at the part representing the earth in a lightning rod, and that when the electricity sent through was certainly not a five thousandth part of that which the rod alone could have carried safely. What then, it may very properly be asked

Digitized by Google

can justify our placing such an instrument as this near a powder Magazine ?

In the first place, it may be replied, that all these striking instances of lateral discharge, are obtained by using a good lateral conductor, having in all these cases but one, a good discharging termination with the earth, and which therefore is itself a lightning conductor acting conjointly with the principal one. In the next place, where it was not in connection with the earth or conductor it was running parallel to it, and, virtually connecting parts at different distances from each other on the lightning rod, and so shewing its functions ; in the next place it is found, as has been stated, that the lateral discharge is always greatest near the top of the lightning conductor (or its representative) and diminishes to nothing towards the lower end, and in the last place, even with the finest wire, and the most exaggerated and best lateral conductor, the lateral spark contained but a small portion of the electricity of the principal or lightning spark.

Now it is by diminishing or removing entirely, the influence of all these circumstances that a lightning conductor becomes a safe neighbour. It should consist of a sufficient body of excellent conducting matter, and it is considered that in this respect a copper rod, one inch in diameter is enough ; it should be well connected by copper plates with the moist ground or water, it should rise high above the building to be protected, it should be placed near to it, that what directive influence it has over the lightning may be used in protecting the building ; it should not come near masses or metal in the building, as a metal roof, or an iron column, or spout of leaden pipe, or bell wires ; or if it does, these should be metallically connected with it, and should themselves not go near to other metallic masses in the building, and remain unconnected with them. In fact, the principle is to make all that may act as conductors, and which *would* act if the lightning rod were not there, a part of the conductor ; that no *interruptions* may occur in the electric course, and to give this course a free discharge into the ground ; the stored powder and such conducting masses being at the same time purposely separated from each other as far as they properly or conveniently can.

Digitized by Google

As a general illustration, I may take Dr. Goodeve's house with its vertical window bolts, and say, that if a good lightning conductor were fixed in that house, and made to run parallel with the bolts at the distance of a foot or so, it is very possible, that, when lightning struck the conductor it might discharge in part to the bolts and much harm might be done, but if those bolts were in good metallic communication with the lightning rod, no harm would be done; and further, if the lightning rod were away, it is almost sure that the bolts without it would be struck, as in fact appears to have been really the case; for I cannot think the striking was due either to lateral discharge, or the attractive influence of the lightning rod standing 60 feet off.

A question has arisen with regard to the surface and the mass of a lightning rod; in the present case the question is of a mixed nature. As a conductor, surface has no influence over the power of the lightning rod, and copper plates or ribbons may not be substituted for a copper rod of equal superfices. The conducting power is as the square of the diameter in round rods, or in fact, directly as the sectional area, whatever the surface may be, a copper rod an inch in diameter is considered as sufficient, the conclusion being the resul t of general observation of natural and experimental phenomena; flashes of lightning, though very awful and exceedingly intense in action, have not so much quantity of electricity in them as many phenomena which continually pass unobserved before us; and frequently cannot fuze copper wires $\frac{1}{4}$ of an inch in diameter, or even such as are only $\frac{1}{8}$ or $\frac{1}{10}$ of an inch thick.

But as every metal opposes resistance to the passage of electricity, and is therefore an imperfect conductor, so surface and the shape of that surface has an influence, and does to a certain extent affect the lateral discharge.

In fact, whilst the conductor, as our wire C, can give a lateral spark, the electricity which can cause that spark, is, in relation to external bodies governed by the laws of statical electricity, and hence the influence of surface, its effect however in a lightning conductor unless purposely exalted and sought for, can be but small.

Digitized by Google

The third point is; *whether at the moment the lightning conductor is struck, it may, by induction upon the gun powder casks lined with copper, or other metallic masses, within the magazine, cause sparks to pass between them, without any actual lateral passage of lightning from the conducctor?* Such a case would according to my view, be a case of returning stroke, and be distinct from lateral discharge, the principles of such a case are easily illustrated. Suppose *A*. fig 33, a charged electrical surface, either that of a cloud, or of a prime conductor; *B* a lightning rod well arranged: and *C* a couple of metallic cases, standing one on the other, but separated by a sheet of paper, a cloth, or a thin piece of wood. As the surface *A* becomes charged positively (we will assume it to be so) the upper end of the lightning rod *B*, and the upper case *A* will become negative by induction.

Upon the discharge occurring to the lightning rod, the induction upon *C* would cease more or less, and it is possible that at that moment a spark should pass between the upper and lower metallic cases. But this can only happen if the cases C have been exposed to the induction of the cloud or machine as it rises in intensity, *before* the spark passes: if they are protected from this, as I think they are most perfectly, by being within a building and under a roof, then no case of this kind can occur.

If the metallic case or other mass of good conducting matter, be both exposed to the inductive action of charged surface, and also near the lightning rod, as at *E*, then the effects of return and lateral discharge may be combined, for before the discharge on to the lightning rod, *E* will become negative by induction, and at the moment of the discharge a lateral spark will pass from the conductor to it to restore its state. A metal roof unconnected with the neighbouring conductor might present this case. These are results very easily obtained with electrical apparatus and machines.

I hasten to bring this letter or report to a conclusion. The whole question is, whether such a low object as a po wder magazine is safer with or without a lightning conductor. I cannot say that I have had very much experience of very powerful thunderstorms, or such as may compare with those in India, but I know

Digitized by Google

that in this country, very low objects are struck, and therefore I should protect by a lightning rod such as I was very anxious to preserve. In place of increasing the number of these around a building, I would rather increase the height of the one or two used by a few feet. The distance from the magazine I would make about, but not further than three feet. The other point mentioned in my former report, I would again beg to urge upon your attention. The water tank at Mazagon powder works, would in my opinion, afford sufficient discharge, provided the communication of the lightning rod with it be made by metallic plates immersed in the water.

Digitized by Google

REPORT *of Experiments on the strength of the undermentioned specimens of Saul Timber, Pegue, and Moulmein Teak Timber.*

Date	No. of Specimens	Nature of Wood.	Specimen. Length. Feet.	Dimensions square in.	Weight. lb.	oz	dr	Bent with 8 half cwt. inch	10 half cwt. inch	12 half cwt. inch	Broke with lbs. including scale 30 lbs.	Average weight broke with	Remarks.
24th November 1841.	1	Saul Timber received from Calcutta	3	1½	3	7	9	·50	·65	·80	926	926	Broke 2 minutes after the 16th weight.
	2	p Bark Euphrasia, in Jany. 1841.	3	1½	3	8	1	·50	·65	·80	926		do. ½ do. do. 16th do.
	3	Register No 1, cut 4th June 1841.	3	1½	3	4	6	·55	·70	·85	926		do. ½ do. do. 16th do.
	1	Do. do. do. do.	3	1½	3	5	10	·50	·65	·80	926	888⅔	do. 3 do. do. 16th do.
	2	Register No. 2, cut 4th June 1841.	3	1½	3	3	14	·65	·85	1·10	814		do. ½ do. do. 14th do.
	3		3	1½	3	6	7	·50	·60	·80	926		do. 5 do. do. 16th do.
	1	Do. do. do. do.	3	1½	3	7	8	·50	·60	·80	814	888⅔	do. 3 do. do. 14th do.
	2	Register No. 400, cut 4th June 1841.	3	1½	3	7	6	·50	·60	·80	926		do. 2 do. do. 16th do.
	3		3	1½	3	8	0	·45	·55	·70	926		do. 3 do. do. 16th do.
	1	Saul Timber received from Calcutta	3	1½	3	8	9	·75	1·00	1·20	814	926	do. 4 do. do. 14th do.
	2	p Bark Ayrshire, in March 1841.	3	1½	3	6	8	·50	·60	·75	1038		do. 2 do. do. 18th do.
	3	Register No. 509, cut 9th June 1841	3	1½	3	6	10	·50	·60	·75	926		do. 2 do. do. 16th do.
	1	Do. do. do. do.	3	1½	3	8	8	·55	·70	·90	814	888⅔	do. 4½ do. do. 14th do.
	2	Register No. 574, cut 9th June 1841	3	1½	3	6	2	·60	·75	·95	926		do. immediately after the 16th do.
	3		3	1½	3	6	8	·55	·70	·90	926		do. ½ minute after the 16th do.
	1	Do. do. do. do.	3	1½	3	0	2	·60	·70	·90	870	870	do. 1 do. do. 15th do.
	2	Register No. 721, cut 9th June 1841	3	1½	3	6	1	·50	·65	·80	1038		do. 2½ do. do. 18th do.
	3		3	1½	3	0	5	·60	·75	1·00	702		do. 1 do. do. 12th do.

251

Digitized by Google

Date	No. of Specimens.	Nature of Wood.	Length. Feet.	Dimensions square in.	Specimen. Weight. lb.	oz	dr	Bent with 8 half cwt. inch	10 half cwt. inch	12 half cwt. inch	Broke with lbs. including 30lbs.	Average weight broke with	Remarks.
25th November 1841.	1	Pegue Teak received from the Commissariat in February 1841. Register No. 56, cut 4th June 1841.	3	1½	2	0	7	·50	·65	·75	1038	944⅔	Broke 1 mintue after the 18th weight
	2		3	1½	1	14	10	·65	·75	·95	926		do. 1 do. do. 16th do.
	3		3	1½	1	13	2	·55	·70	·85	870		do. 3 do. do. 15th do.
	1	Do. do. do. do. Register No. 58, cut 9th June 1841.	3	1½	2	7	1	·60	·75	·95	926	926	do. 1 do. do. 16th do.
	2		3	1½	2	6	7	·65	·80	·95	926		do. ½ do. do. 16th do.
	3		3	1½	2	6	6	·55	·70	·85	926		do. 2 do. do. 16th do.
	1	Do. do. do. do. Register No. 100, cut 9th June 1841.	3	1½	2	0	2	·60	·80	1·00	926	944⅔	do. immediately after the 16th do.
	2		3	1½	2	0	9	·55	·70	·80	926		do. 2½ minutes after the 16th do.
	3		3	1½	2	4	1	·50	·65	·75	982		do. ½ do. do. 17th do.
	1	Moulmein Teak & Bark Euphrasia, recd. thro' the Commisst. in April 1841. RegisterNo.8,cut 4thJune1841	3	1½	2	3	15	·70	·85	1·50	814	739⅓	do. ½ do. do. 14th do.
	2		3	1	2	4	0	·60	·75	·95	814		do. 2 do. do. 11th do.
	3		3	1½	1	15	9	·85	1·10	0	590		do. 3 do. do. 10th do.
	1	Do. do. do. do. Register No. 19, cut 9th June 1841	3	1	2	0	10	1·30	1·60	0	534	534	do. 2 do. do. 9th do.
	2		3	1½	2	0	15	1·25	1·70	0	590		do. ½ do. do. 10th do.
	3		3	1½	1	15	15	1·20	0	0	478		do. 4 do. do. 8th do.
	1	Do. do. do. do. Register No. 44, cut 9th June 1841.	3	1½	2	6	6	·65	·80	1·10	702	720⅔	do. 1 do. do. 12th do.
	2		3	1	2	9	6	·65	·85	1·20	702		do. ½ do. do. 12th do.
	3		3	1	2	8	6	·60	·75	1·10	758		do. 1½ do. do. 13th do.

Gun Carriage Manufactory, Madras, 26th November 1841.

(Signed) J. MAITLAND, *Captain, Supt. Gun Carriage Manufactory.*

Digitized by Google

To The

DIRECTOR ARTILLERY DEPOT ST. THOMAS'S MOUNT.

Sir,—I now write to redeem my pledge, either to justify or abandon the opinions advocated in my Pamphlet,* in answer to Lieut. Ash, Bombay Artillery, whose "Remarks"† have just reached me.

A portion of his "Remarks" being criticism on my style, my "manner" of over-ruling objections &c, I leave unanswered; the main objections he makes I will advert to as briefly as I can.

In November 1839, I think it was, my light 18 pounder iron gun did, with 5½ lbs. of powder, throw shot to precisely the same height upon a target 1000 to 1200 yards distant, as the long 18 pounder with 6 lbs. of powder, elevation being the same—my gun was about 18 inches nearer the ground, therefore the velocity must have been a trifle greater.

Perhaps you will be kind enough to give the particulars,‡ of which a copy must exist in the Office; Major Blundell, Colonel Montgomerie, Major Wynch, and many others saw it, and admitted the great superiority of the short gun in accuracy.

This I think, an answer to much of Mr. Ash's brochure, particularly to his belief that to make a very light breaching gun is as practicably impossible, as it would be to make a light anvil for heavy work.

I will give two quotations bearing on this point.

Gregory's "Lectures on Gunnery" says, "Some of the expe-
"riments made by Sir T. Bloomfield and Mr. Hutton, were
"directed to this very point, and it was proved indubitably
"that while the strength of the powder, and bore of the
"gun were the same, no change followed in the initial velocity
"from varying the weight of the gun, increasing the metal
"about the trunnions, or about the breech and cascable, by dimin-
"ishing recoil, or by preventing it altogether. Mr. Robins also
"lays down that cylinders of equal bores, and equal lengths, with
"equal charges of powder and balls, will discharge their shot

* Vide page 137.

† Vide page 158.

‡ Given at the end of this letter, page 264.

Digitized by Google

" with equal velocity, and adds, we must insist on the truth of " this maxim, how opposite soever to long established prepossessions."

And Sir Howard Douglas ; naval gunnery, p. 121.

" Varying the weight of the gun, produced no change in the " velocity of the ball."

Lieut. Ash has been misled by Sir Howard's work, in which there is a very striking inaccuracy, contained in the passage which Lieut. Ash quotes.

Sir Howard compares the performance of the long 24, with that of the short, and Lieut. Ash draws the inference that the reduction of *only* 17 cwt. diminishes the utility of the piece by $\frac{1}{3}$th : now if we turn to the Table VIII, page 294, in Sir Howard's own book we shall see, that by an oversight most likely, Sir Howard has compared the ranges obtained by the long gun with 8lbs. of powder, with those of the short gun using only 6lbs. ; which is about as fair and as conclusive, if intentional, as the Woolwich trial of my gun, when fired with 4lbs. to theirs when fired with 6lbs.

Compare the performance of the 2 guns with equal charges !

	with 6 lbs.	with 4lbs.
Long gun—Point blank	248	265
Short ,, ,, ,,	221	288
Difference	27 in favor of long.	23 in favor of short.
Long gun ; at 2° Elevation	847	777
Short ,, ,,	832	745
Difference	15 in favor of long gun.	32

so that 15 yards range in 850 or 1 in $56\frac{2}{3}$ is all that we really lose by cutting away $\frac{1}{4}$ of the length of gun, 17 cwt. of iron !

Lieut. Ash is diametrically opposed to me in all points, insisting on the advantages of heavy guns, heavy carriages, and avowedly " a great advocate for heavy proportion of dead weight."

But he will I am sure be glad to get rid of some of the weight to be dragged, when he finds that the light gun *does* fulfil all the expectations of its constructor, does realize those conditions which Lieut. Ash lays down as required in a battering gun, " all of which" he says " imply great weight of metal ;" that is it does throw its shot with equal momentum at equal angles with $\frac{1}{3}$ of the charge re-

Digitized by Google

quired for that long gun which it is intended to supersede: and its recoil may be made more or less according to the will of the Officer in charge.

Lieut. Ash thinks nothing but dead weight can check recoil: does hethen imagine that the recoil will be the same, however the axle is placed relative to the centre of gravity of gun and trail?

Supposing in any gun now in use, I move the axle so far astern, as to be very nearly under the centre of gravity of gun and trail, so nearly that a pound or two pressing on the muzzle would raise the end of the trail in air; does Lieut. Ash think the recoil will not be more lively than it now is?—clearly it will, and following out the reasoning, he will I think agree with the principles contained in my pamphlet p. 20.*

It is *not* weight that checks recoil, or rather that should be used to check it, but the relative placing of the absolutely indispensable weight; the present system maximizes the dead weight to be drawn by our cattle, minimizing the resistance offered to recoil. I propose to reverse this, minimize the dead weight to be dragged, but employ every pound of it to check the too lively recoil: let the profession decide between us.

Lieut. Ash thinks the iron trail will *bend*. If you will kindly give a drawing to scale of my carriage,† and specify thickness, weight, length, and depth, his fears will be removed. Its shortness secures it, as I pointed out in my pamphlet.

Lieut Ash admires the caution which induced Robins to specify only 18 pdrs. and downwards: now I think his motive was the same as mine; in his day the Navy (vide James, Brenton, and others on naval history) used a vast proportion of 18 pdr. 12 pdr. guns, 9 and even 6 pdrs. The 18 pdr. he recommended should be made into 24, and so on, simply because these were the guns then in use, which were objectionably heavy in proportion to their power; and my motive is just the same. I don't propose to ream out the huge 32 pdr. gun; I don't even meddle with the 24 pdr. simply because I am advocating a measure to benefit the Indian

* Vide page 152. † Vide fig. 34.

Digitized by Google

army, and will never recommend their having 32 pdrs. in any other shape than the carronade, or a brass howitzer.

Lieut. Ash objects to my illustration of the path of a ball in the bore; I give it up: but it was merely an illustration, a simile, expressly introduced with the word "somewhat similar."

Lieut. Ash thinks that fouling by firing is the grand secret which should decide windage: but I argue that if you will diminish windage, you may both shorten the bore, and diminish the charge; and I have proved it: Lieut. Ash will perhaps admit that fouling will depend principally on the two points, actual quantity of powder ignited, so as to form a residium, and superficies on which the residium may be deposited. Both of these I diminish—How then argue that diminution of windage (by which alone I am able to diminish fouling) is not permissible, because of fouling?

The bore I have given does not foul too much, is amply sufficient, *(probatum est)* for firing hot shot, and in fact is considerably more than I would give in a future construction.

I now come to Lieut. Ash's observations on wrought iron as a material, which he says "we perceive at once to be one of the "worst materials which could be used.

He expresses very accurately the question, and then makes a few observations, which he requests all Artillery Officers to bear in mind.

He notices the great weight of the English carriage; then the great weight of the English gun; then that Sir H. Douglas reduces the charge with the windage (which I have also done, in precisely the same spirit as Sir H. D., that is to acquire *equal* range at equal elevation); then the placing of trunnions in English guns; then the refuted assertion of the Woolwich Committee, and other points which I need not now quote, as they are all fully discussed in my pamphlet.

Now I pointed out the two first of these in my first pamphlet, but with a widely different intention—Lieut. Ash quotes them apparently to impress upon the Artillerist the great improbability of my being right, when I differ so widely from Woolwich—I am

Digitized by Google

fully aware of the disadvantage I labour under, but the Select Committee at Woolwich, when they pronounced my arguments erroneous, did not prove them so; I still hold the opinions then denounced, so cannot admit that my theory is wrong, *because new.*

The Woolwich Committee asserted that iron carriages were destroyed at once by shot striking them:—in reply I shewed that 2 out of the three component parts are actually safer; the wheels having been proved so by their own Committee:—the axle necessarily so, because having actually less iron than theirs; and that the iron trail, covering only ¼ of the space of the wooden cheeks, incurred only ¼ of the danger, was far more easily replaced if injured; and lastly, that the ill success of one or two experiments in the construction of iron carriages, on different principles altogether from mine, no more authorized the condemnation of iron as a material, than the breaking down of any timber carriage (and I have seen plenty of them break down, and heard of more) does the condemnation of wood.

The Woolwich Committee reason thus:—The first experiment was a failure: the principle therefore shall be denounced; hundreds of wooden carriages have failed, but they shall be continued; altho' one failure in iron shall exclude iron.

Most of Lieut. Ash's other doubts and fears are set at rest I hope by this time, by the actual success of the experiment, of which he augurs so unfavourably, and I will only remark, that I asserted the ease with which a cheek of my trail could be changed, because I saw it done, by the people in Bramah's yard, Pimlico, in a very few minutes with ease, one man carrying the cheek away, and bringing it up again: and in reply to his last, I answer "yes:"—The proposed gun and carriage *is* equal to *any* 18 pounder in the service: in all ways it is superior to any 18 pounder in the service!

(Signed) P. ANSTRUTHER, Captain,
Madras Artillery.

At sea on board the Rustomjee Cowasjee, 12th Sept. 1841.

Digitized by Google

MEMORANDUM *of firings from* CAPTAIN ANSTRUTHER'S *light* 18 *pdr. and one in common use* 9 *feet in length, both mounted on heavy Field Carriages, with wheels of the same height.*

3rd February 1840.

No. of Firings.	Ordnance.	Charge. lbs.	Charge. ozs.	Elevation. D.	Elevation. M.	Flight. S	Flight. P.	Recoil. feet.	Recoil. ins.	Distance of Target. yds.	REMARKS.
1	Capt. Anstruther's light 18 pdr. weight 21-2-14.	5	0	2	0	3	0	4	6	1000	Struck the Butt 18 feet from the ground
2		5	4	1	45	3	0	4	10		" " 16 " "
3		5	4	1	45	3	0	4	6		" " 12 " "
4		5	4	1	45	3	0	4	4		" " 18 " "
5		5	4	1	35	2	45	4	7		" the Target 4 feet. "
6		5	4	1	35	2	45	4	4		" " 9 " "
7		5	4	1	35	2	45	3	8		" " 2 " "
8		5	4	1	35	0	0	4	2		Over the Butt
1	18 pdr. in common use weight 42-2-22.	6	0	2	0	0	0	4	6	1000	Over the Butt.
2		6	0	1	45	2	15	5	0		Struck the Butt 8 feet from the ground.
3		6	0	1	45	2	30	4	6		" " 15 " "
4		6	0	1	45	2	30	4	4		" " 14 " "
5		6	0	1	35	0	0	4	4		Over the Butt.
6		6	0	1	35	2	15	4	6		Struck the Butt 7 feet from the ground.
7		6	0	1	40	0	0	4	6		Over the Butt.
8		6	0	1	30	2	30	3	8		Struck the Butt 15 feet from the ground.

The first four rounds were fired at a Target fixed on the face of the Butt as high as could be, the other four rounds were fired at a Target placed as for Practice, in front of the pile for hot shot.

Digitized by Google

STATEMENT RESPECTING THE NEW SERIES OF MILITARY AND NAVAL PERCUSSION ARMS, AND THEIR APPROPRIATE AMMUNITION, &c. &c.—7TH MAY 1841.

MILITARY PERCUSSION ARMS.

Musket, Rank and File, for Foot Guards, Lovell's pattern of 1838.

Musket, Rank and File, for Regiments of the Line, pattern of 1839.

Musket, Serjeant's rifled, for Foot Guards, (two-grooved barrel.)

Muskets, Serjeant's plain, for Regiments of the Line.

Rifle, Lovell's improved Brunswick pattern, (two-grooved barrel,) with sword bayonet.

Carbine, Victoria pattern, with swivel rammer, for heavy and light Cavalry.

Carbine, double-barrelled, (not rifled) with swivel rammer, for the cape mounted rifle corps,

NAVAL PERCUSSION ARMS,

Musket, Sea Service.
Pistol, Sea Service.
Rifle, heavy Naval pattern.

The nipple and the percussion cap or primer, are the same for all arms; both Military and Naval.

MILITARY PERCUSSION ARMS.

The calibre of all percussion arms for Infantry rifle corps, and Cavalry, are so far approximated that they all receive the musket ball and therefore may be described as of the musket bore.

The several charges of powder are as follows:—

The musket ball cartridge.....	$4\frac{1}{4}$ drams.
Rifle ball cartridge.....	$2\frac{1}{3}$ „
Carbine ball „	$2\frac{1}{3}$ „
Blank cartridges for all percussion arms	$3\frac{1}{2}$ „

The ball for muskets and carbines is the "Old English Service ball," weighing $14\frac{1}{2}$ to the lb.

The ammunition for the percussion musket and carbine is made up like that for arms with the flint lock, viz., the

Digitized by Google

blank cartridge for exercise in blue paper, and the ball cartridge in white fine paper.

The rifle is loaded with blank cartridge, loose ball, and greased patch. The ball is belted, and tied up in the calico patch with a black band round, shewing the belt —The cartridges are made up and packed up in dark green paper to shew that they are made with rifle powder. A proportion of tallow is issued with the ball for greasing them. The weight of the belted ball is 12½ to the lb.

The ammunition for the "Rifled Musket for Serjeants of the Foot Guards" is the same as for Lovell's Brunswick rifle.

The ammunition for the "Plain Musket for Serjeants of the Line" is the same as for the muskets for rank and file.

The light carbine for the Royal Sappers and Miners, and the double barrelled carbine for the Cape Corps, are served with ammunition similar to that of the Victoria carbine.

The Royal Marines are equipped with arms and ammunition similar to those supplied to Regiments of the line.

The proportions of ammunition to be supplied for each descriptions of percussion arm, are subject to the same regulations as those for flint locks.

The proportion of percussion caps or primers for all arms is five to every four cartridges, or one-fourth more caps than the number of cartridges supplied.—The caps are supplied packed with the ammunition.

All Regiments of Cavalry and Infantry, excepting Rifle corps, are furnished with a leather pouch and a tin magazine to hold the percussion caps. But these articles are supplied by the ordinance only with the first equipment with percussion arms to the extent of the several Regimental Establishments, and are paid for by the secretary at war. The same rule applies to the Royal Marines, repayment being made by the admiralty.

The soldier's general supply of percussion caps is carried in the magazine which is placed in the cartridge-box.

The caps intended for immediate use are carried in the small pouch made of patent leather on the outside for the better resistance to wet. This pouch is attached in Infan-

Digitized by Google

try Regiments to the coat on the right side by means of a ring, and so fixed as to be clear of the belt. In the case of cavalry Regiments it is attached to the waist-belt.

Rifle Regiments are supplied with the tin magazine only, the caps for immediate use being carried in a pocket attached to the ball-bag of the Rifleman's accoutrements.

The implements in use for the musket and carbine are the following, and they are supplied to Regiments in the proportions annexed:

One three arm nipple-wrench, with turn-screw, pricker, and worm.
One spring-cramp for the lock, three spare nipples.
} To each Serjeant and Corporal of the several Companies of a Regiment.

Making a proportion of eight of each of the former tools, and twenty-four spare nipples, to each company.

The Ordnance Department has hitherto never furnished the soldier with implements for taking off the lock, or the part thereof for oiling it, nor is it desirable to encourage him to do so, more especially with the superior locks fitted to percussion arms, much injury being done to locks by frequently taking out the screws and the springs, but as small detachments may occasionally have no means of obtaining the assistance of an armourer, either for replacing a defective nipple, or for taking off and oiling a lock requiring that operation, the foregoing proportion of implements is supplied to the Serjeants and Corporals it being understood that the articles are to be strictly kept for the emergencies alluded to.

The implements in use for the rifle and rifled musket are as follow:

One three-arm nipple wrench, with turn-screw and pricker (without the worm.)
One ball drawer
One brass jag.
} carried in the trap
} These are supplied with each rifle and rifled musket.

Each Serjeant and Corporal of the several companies of rifle Regiments, are furnished with the following implements also for the use of small Detachments in cases of emergency as before mentioned with respect to Regiments armed with muskets or carbines, viz:

One spring cramp for locks.
Three spare nipples.

The arrangement made by the Master-general or Board, with the General commanding in chief, for supplying Regimental Serjeant armourers with the various articles required for the repair of the new series of percussion arms, from the ordnance stores at the cost price of those articles, and the list of prices which the armourers are authorized to charge for

Digitized by Google

executing such repairs, are detailed in the General Orders dated Horse-Guards 30th March 1841, No. 552.

Naval Percussion Arms.

The several charges of Powder are as follows :

The musket	Ball cartridges	4½ drams
	Blank do.	3½ ,,
The pistol	Ball do.	2½ ,,

The Service musket ball is the same as that for land service viz. 14½ to the lb

The pistol ball weighs 34 ,,

The heavy naval rifle ball very nearly 8 ,,

The heavy naval rifle is loaded with blank cartridge, loose ball and greased patch—The ball is belted and tied up in the calico patch with a black band round showing the belt.—The cartridges are made with 3½ drams of rifle powder, and packed in green paper.

The proportion of ammunition supplied for the sea service percussion musket and pistol is the same as that fixed for flint locks.

The number of ball cartridge supplied for the heavy naval rifle is 150 rounds to each rifle.

The proportion of percussion caps for the navy is five to every four cartridges, or one-fourth more caps than the number of cartridges supplied.—This proportion is packed with the ammunition, and, in addition, one cap is supplied for each cartridge which the materials will make up, that are to be issued for the preparation of ball and blank cartridges for the exercise of the men according to the scale inserted in the naval proportion.

The following implements for the sea service musket and pistol, are supplied in the proportion annexed :—

The three-armed nipple wrench, with turn-screw, pricker and worm.	1 to every 18 muskets.
	1 to every 18 pistols,
Spare nipples.....	1 to every 6 muskets.
	1 to every 6 pistols.

Spring cramps for the lock....2 to each of H. M. Ships.

The implements for the heavy rifle are :—

One three-arm nipple wrench, with turn-screw and pricker without the worm.....	Supplied with each rifle.
One ball drawer....	carried in the rifle trap
One ball jag.....	carried in the rifle trap

One bullet mould to every 6 rifles.

Each rifle is also furnished with a plug-rod covered with woollen and greased, put into the barrel to preserve the interior from rust, and it should be so kept, when on board ship.

By order of the Master-General and Board.

R. BYHAM, *Secretary.*

Digitized by Google

SHAFTS WITH LIGHT FIELD CARRIAGES.

Letter from Captain-Lieut. E. HARDY, *Bombay Horse Artillery, to Colonel* SMITH, *Commanding P. S. Force, dated Jaulnah, 3d September* 1816.

I have now the honor of reporting for your information, the result according to the best of my judgment, of the trials lately made, in consequence of the instructions which I received from you to that effect, with the new pattern shaft gun carriage which arrived in Camp from Ahmednuggur during the last month.

I have exercised the shaft carriage several times, with a gun mounted, limber boxes filled with ammunition, and two men upon them, separately as well as in Brigade with the other carriages; and am decidedly of opinion, that the construction is very advantageous, and that it is desirable to adopt it for the service of the Horse Artillery.

The trials that have been already made fully establish in my mind all the advantages which the construction promises on inspection: and not a single objection has been discovered by any individual in the Horse Brigade.

The wheel horses are of course alone effected by the difference, and they both appear to be greatly eased by the change. The near wheel horse, has no weight to carry besides the driver on his back The off horse, although he carries the whole weight himself, is still materially eased by its resting on his back instead of the neck, and by its being equally divided on both sides. In halting at speed, both horses are greatly relieved by the stress of the forward movement of the carriage acting against the back, instead of the neck, as is the case with poles: and the inside part of the near horse's breaching being fastened to the shaft as well as the breaching of the other horse, both assist in stopping the carriage almost equally. This method of fastening the breechings to the shafts instead of the collars, also gives the horse great additional support in halting and going down hill.

The haimes of the wheel horse's collars which are frequently broken with poles, are not liable to be injured with the new carriage. Neither do the straps which support the shafts appear liable to any injury; while the pole pieces or chains, often give way to the force of the poles acting against them.

Digitized by Google

The shafts are certainly a great assistance in managing restive horses, and afford the most effectual means of using kicking straps.

I am not prepared to say whether the shafts are more likely to break than poles or not: it appears however probable, and from the greater difficulty of procuring wood proper for the purpose, requires to be particularly provided for. This in my judgment need not create any difficulty. The shafts are readily shifted without occasion for workmen or tools, excepting a common hammer; a sufficient number of spare ones can of course be furnished, and two may be disposed very conveniently on each ammunition carriage, which would be an ample proportion.

There is another advantage in the shafts: they can be shifted so as to answer for a single horse in draught, which under some circumstances would give it a particular preference, as on a confined road in a mountainous country, or in case of an extraordinary loss of horses. And I beg now to observe that the French mountain Artillery carriages are made on this principle.

The alteration necessary for the harness is extremely trifling, and does not by any means prevent its being used with pole carriages when required.

I take this occasion to remark, that the limber boxes of the new carriage, are not fitted up with the small partitions between the shot in the manner which I had an opportunity of seeing in the Europe Pattern Carriages at Bombay, and which in my humble opinion are admirably contrived and much wanted.

CONGREVE'S ROCKETS.

Letter from Lieut. Col. H. HESSMAN, *Bombay Artillery, to the Adjutant General of the Army, dated Camp at Seroor, 28th March* 1819.

I now proceed to report upon the Congreve Rockets in compliance with the orders of the Commander-in-Chief contained in your Letter of the 10th of October; the long delay that has taken place has arisen from my having ever since been absent from my baggage and papers, which have not yet joined me. To avoid however a still greater loss of time, the enclosed report is framed from memory, I have been consequently precluded from entering into those

Digitized by Google

minutiæ which a reference to the practice book alone could have enabled me to have stated.

General Report upon the practice with Congreve Rockets, the usefulness of the weapon for warlike purposes in India and efficiency of the Establishment.

Para 1st. The practice with Congreve rockets on the Bombay Establishment has almost exclusively taken place in Guzerat in the year 1817, under my immediate direction, they were found upon the two first trials to be so bad as to materially endanger those employed in the practice, in fact they usually burst at the first moment of ignition, this I was, upon reflection, led to attribute to the shrinking of the composition from the heat of the climate, by which together with their being shook in travelling, vent was produced at the head of the rocket and the premature bursting as consequent upon the general ignition which in that case would of course take place : under this impression I ordered several 18 pdr. rockets to be opened at the head, when my opinion was fully verified by the composition being separated from the case, and evidently moving when violently shook with the hand.

2d. In order to ascertain whether rockets in that state could be made serviceable, I directed a strong composition to be poured into the heads, and after securing them as well as possible they were fired and with invariable success, provided, they were used on a frame and were furnished with shells cast with an iron tompion strongly glued into the case ; those alone we found it possible to secure firm enough. Those with round shells fixed by means of a wooden bottom, generally failed, owing to the bottom shrinking and splitting and probably occasioning the composition in the head of the rocket to crack at the same moment from its adhesion to the wood.

3d. Few of any rockets so repaired, failed when fired from a frame, and a few succeeded when fired from the ground ; in the latter case the agitation of the rocket previous to its quitting the ground usually knocked off the shell, and occasioned the case to burst within the first hundred yards.

4th. The practice with rockets so repaired, as well as with some that appeared to have suffered less deterioration, was so excellent as to prove, that whilst undamaged, much might

Digitized by Google

be in certain cases expected from that power. Experience has however clearly shewn that the efficiency of those sent from Europe cannot be relied on; *they must therefore be made in India:* and I have no hesitation in affirming from my own experience with a composition of the same power as the original one, that they can be made as good here as at Woolwich, with the exception of the shells, which should be provided annually from England; by this means a considerable reduction will take place in the expense, both with regard to the prime cost, and tonnage, and as no more need at any time be made, than will be required for annual practice or for Forces, as they take the Field, a constant supply of fresh and undamaged rockets can be relied on.

5th. The foregoing remarks relate exclusively to the *Shell Rockets*, the few trials that were made with conflagration rockets were perfectly successful; owing no doubt to their construction being such as to preclude all possibility of their finding vent at the head, to which alone I attribute the frequent failure of the shell rockets.

6th. As to the utility of the rocket for warlike purposes in this country, it would appear to be far less general than in Europe where their greatest use is in the bombardment of large seaport towns from a distant anchorage, even in our sieges they may be considered of less use than elsewhere, as the space they require to be thrown into, is commonly so small as to add to the uncertainty which attends their application even in common cases and which is materially increased in windy weather; added to which it is not so much the garrison as the unoffending and in most cases neutral inhabitants, that suffer by them; and it must also be kept in mind, that such is the certainty of our success, that every place we set down before ought, from that moment, to be considered as our own property, and (as far as possible without risk of failure) spared accordingly.

7th. This of course applies to the conflagration rocket only; in the usual case of attacks on fortified Towns, and not on Hill Forts, or places containing a garrison only, in the latter instance bombardment of every description is applicable and requisite, and from that by the large sized rocket, much may fairly be expected, when the space is sufficiently extensive to give a chance of tolerable practice.

8th. It is from shell rockets, namely the 12 and 18

Digitized by Google

pounder used as Field Rockets, and from the 24 and 32 pounders in bombardments, that most advantage is to be expected in Indian warfare; the Field Rocket in particular I consider as an arm of first-rate importance and efficacy against Indian Armies, provided the rocketeers are mounted.

9th. As to the rocket establishment with the Bombay Army, none can be said to exist; a few men from the native Cavalry, Artillery, and Light Infantry were indeed trained, but never taken from their Cops for that particular purpose; in fact, it has been hitherto considered with us as merely experimental, enough however has resulted to shew, that rockets could in our future campaigns be rendered eminently useful, but as before stated, they must be made in India.

MONCKS' GUN.

The dimensions of this gun are,

Length from cascable to muzzle	11 feet.
Weight	97cwt. 3qrs.
Bore	$7\frac{7}{10}$ inches.
Solid Shot Weight	42 lbs.
Windage	0·175
Charge	16 lbs.
Elevation	32 deg.
Range	5327 yards.

A "compound shot," a shell filled with lead, was projected 5720 yards, or three miles and a quarter, at a velocity during the first second, of time of 2400 feet per second, and occupying during the flight only 29½ seconds.

The comparative weight of the gun and shot is 1 to 220.

This gun is intended to be placed on promontories and headlands of maritime districts, to prevent any attack from steamers &c. and other purposes for which its extreme range fits it.

Ranges with this Gun.

P. B.	1°	2°	3°	5°	10°	15°	elevation.
400	700	1360	1750	2260	3200	4150	yards.

Digitized by Google

MODE OF ATTACHING ADDITIONAL DRAFT WITHOUT INCREASING THE LENGTH OF THE COLUMN OF HORSE ARTILLERY GUNS, &c., AS PRACTISED BY CAPTAIN BRIND, BENGAL HORSE ARTILLERY, Fig. 35.

A.—A swinging bar of about two feet in length, having an iron loop in the centre, and one at each end ; made of ash or any tough wood. B. A piece of two inch Europe rope, with a common hook at each end, (the length of the rope about ten or twelve feet ;—or rather, of such a length as will bring the horse attached when in draft, abreast of the pole horses) one hook to be fixed in the eye of the centre loop of the swinging bar, and the other to be fixed to the drag washer C of the hind wheel (gun or waggon). A horse with pole traces is attached by fixing the trace hooks to the loops at the end of the swinging bar. By this means, four horses abreast may be attached, and a team of twelve horses can work (without extending the column of march) in a heavy sandy country, where the breadth of the roads admits. I have tried this mode with success, particularly when crossing the river Soane, which owing to its heavy sandy bed, of about three miles across, is reckoned a march of itself. I have even wheeled and reversed a team of twelve, but it is not a happy manœuvre, tho' in a steady draft, such a team will overcome any difficulty.

A similar mode to this was proposed some years back, by a very able Officer of Bengal Horse Artillery, who wrote under the well known signature of " old jack boots" but his proposal entailed an alteration in the drag ropes now in use and also drawing from the front wheel. Captain E. Buckle our Assistant Adjutant General Artillery, hinted to me the advantage of drafting from the hind wheel, and I'm satisfied it is the best mode.—Again, two inch rope is much wanted with each carriage, it is very useful for mounting and dismounting the guns and carriages, and the drag ropes may be required simultaneously with the swinging bars ; on these grounds I deviated slightly from his original proposition. I only prepared eight of these bars, ropes &c., and by this means I attached four horses abreast at the pole, or eight horses in all to two guns and two waggons,—the remaining four guns and four waggons had each eight horses in pairs; and the whole crossed with equal facility, although the evening was warm, and the sand the heaviest for any continuance, I ever met with.

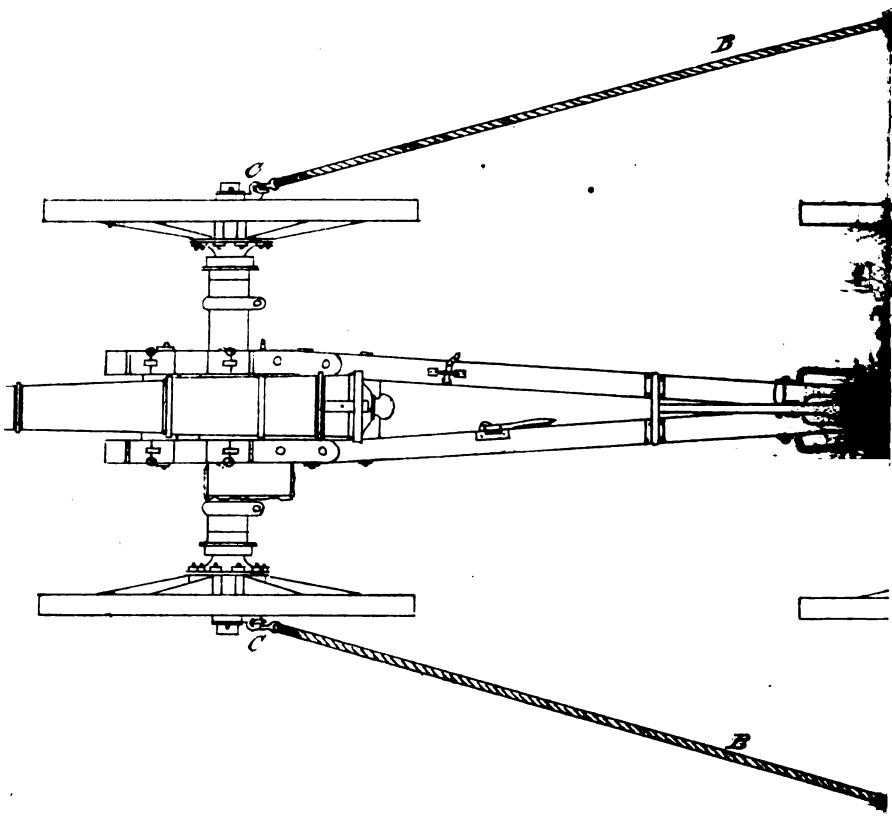
Digitized by Google

Digitized by Google

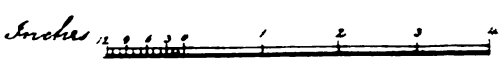
Misce

Method of increas

without length



Scale



Digitized by Google

Digitized by Google

Digitized by Google

NEW PATTERN INDIAN FIELD CARRIAGES.

Letter from Captain J. M. Martin, Commanding 3d Troop Horse Brigade, dated Bombay 22d September 1841, *to the Secretary to the Military Board, Bombay.*

May I request you will do me the favor to lay the following remarks connected with the new pattern gun, and Ammunition carriages, of the Battery now under my charge, before the Military Board : in order that they may, should the Board deem them of sufficient importance, be brought to the notice of the Artillery Select Committee.

Copper Magazines.—These are in my opinion useless, and a needless expense—and I recommend that they should be abolished ; but if they must be retained they should be much stronger than they are at present ; and as this would necessarily render them heavy, and unfit to be taken out of the boxes every time the gun is brought into action, they should be *fixtures.* They should be made to open longitudinally, or (as I believe those formerly in use with the Madras Artillery had) have a round or square hole in the centre of the top ; with a cover ; the cover being secured to the top of the Magazine, by a light brass chain to prevent its being lost—The Magazines now in use are very badly made, and the metal is so thin, that when they are taken out of the boxes for Field Exercise, the weight of the cartridges bulges them so much as frequently to prevent their being put back again—From the same causes, the lids bend, and do not close properly, and from being made to open transversely--they are liable to be wrenched off, or otherwise injured by the lids of the Ammunition boxes closing, whilst the Magazines are open ; and this is a circumstance of frequent occurrence, from there not being any long joint hinges to keep the boxes open.

The painted canvass Pouches formerly in use, are I think superior to the Copper Magazines in every point of view—I can bear witness to their being safe ; for since I joined the Horse Artillery upwards of twenty-one years ago, I never knew the slightest accident to have been caused by their use —They effectually preserve the cartridges from damp : they prevent the powder shaking loose in the boxes ; they are particularly handy both in action, and at Field Exercise ; they are easily transported by a horseman in crossing a river, or in quick advances or retreats, leaving him at the same time both hands at liberty, either for defence or for

Digitized by Google

the management of his horse—whereas in a similar situation with a Magazine both hands would be occupied, and if attacked, the natural impulse of self preservation, would cause the Magazine to be thrown away—and last tho' not least, two rounds can be fired each time on coming into action, where Pouches are used, to one where Magazines are used.

If the Magazines are abolished, two canvass Pouches will be required to each Ammunition box—but if the Magazines are made fixtures, two Pouches to each limber will be sufficient.

Lids of Ammunition Boxes recommended to be stuffed.—The lids of the new pattern Ammunition boxes are not stuffed, which is objectionable for the following reasons, viz.

1st. From the surface being hard and smooth the men cannot sit so firmly on them, as they can on stuffed ones; and they are therefore more likely to receive injuries when going over rough ground

2d. The men's overalls are worn out by friction against such a hard substance.

3d. When the carriages are exposed to the sun, the copper tops of the boxes become so much heated as to cause the wood underneath to crack and open, and several of those of my Battery, have already opened more than half an inch—this would be remedied by stuffing, as the heat could not then penetrate to the copper.

4th. The canvass from being stretched tight and nailed over the sharp edges of the copper and wood, soon cuts and wears out, as may be seen on an inspection of my Battery which has been in use only a few months; stuffing would remedy this also.

5th. A man cannot go through a Field Day Parade on one of these hard boxes, without experiencing serious inconvenience either from chafes or bruises; and as the health and comfort of the men ought to be studied in the performance of their duties, this last objection alone, ought to be sufficient to cause the stuffed tops to be again adopted.

Long joint Hinges.—Long joint hinges, such as were formerly in use, are required to prevent the lids of the Ammunition boxes from falling down, and injuring the arms of

Digitized by Google

the men when taking out Ammunition or when packing the boxes; a man cannot easily take out a shot, without using both hands, the least move of the horses causes the lid to fall down and the man's arms or hands thus become injured—The long joint hinge not only prevents this, but also prevents the lid of the box from straining the hinges, when thrown open.

Lids of small Store Boxes.—The lids of the small store boxes should be made in one piece—with the hinges at the back—those in my charge have an opening along the whole of their length through which the rain penetrates; and the small stores receive considerable damage—Those already made should be covered with painted canvass—The hasps of these boxes should be placed outside the lids—situated as they now are they break away part of the wood work on the boxes being opened.

Perches of Ammunition Carriages.—The perch of the new pattern Ammunition carriage runs along the whole length of the platform, and cannot be replaced or removed without removing the whole of the frame from the axletree; and unlashing and taking off, the four Ammunition boxes—A very large piece of timber is required to make a perch of this pattern, and should one of them break, which is not unlikely from the circumstance of their being much weakened, where they ought to possess the greatest strength, by two large bolts passing through them, to fasten on the saddle for a spare wheel: it would be next to impossible to replace it except from an Arsenal or from some of the principal Stations—It would have been impossible to have procured a piece of timber of sufficient size to replace a perch of this pattern, during the transit of the Army of the Indus through Scind and Affghanistan; and for want of such a piece of timber, the broken carriage must on that service have been left behind or destroyed; and the Battery it belonged to, would on being called into action have been deficient of so much of its Ammunition—To guard against such a contingency as much as possible, I beg to suggest, that a plate of iron about a quarter of an inch thick, and three or four feet in length, be placed along the lower side of the perch; extending to the front, and rear of the spare wheel saddle; this plate should be let into the wood, and secured by the two bolts of the saddle, and by the two smaller bolts immediately in rear of it—The expense of adding the iron plate to the new perches

Digitized by Google

would be very trifling, and I think that with it there would be but little chance of their ever breaking; I have proved the efficiency of the iron plate as will appear from the following statement, at the commencement of the Scind campaign I observed one of my perches (of the old pattern) to be badly cracked, and as I was not able to get a piece of wood to replace it, I put a plate of iron underneath it and it was the only perch of my Battery that did not break before the termination of the campaign—Even supposing that a piece of timber of sufficient size to make a perch of the new pattern could be procured, I much doubt whether after a march the Troop Artificers would have time to make and replace a new pattern perch during the remainder of the day, for on one occasion in Affghanistan during a twenty-four mile march two of my perches broke—the carriages were brought into camp with great difficulty—and altho' on this occasion I had the assistance of the 4th Troop Artificers, neither of the perches (altho' small ones) were finished, when the force marched the next morning; altho' the Artificers had worked hard all night—The consequence was, that a strong guard had to be left with them for a couple of hours till they were finished.

In making up new carriages I think it would be well to have the perch quite distinct from the frame—it ought not to extend further than the axletree bed—it should be a little thicker than the old pattern one, and there should be an iron plate along the whole length of it—some improvement might be made in the method of letting it into the axletree bed, which the experience of the Committee will no doubt enable them to suggest. The shank of the iron work next the axletree should be made about an inch and a half longer than it formerly was, and the iron plate should be fixed with pins—riveted all through—instead of with screws which are constantly falling out. The great advantages the short moveable perches possess over the new pattern ones,—in the facility of replacing them and the ease and rapidity with which they may be removed from one carriage to another—are strong advocates in their favor.

Resting Bars.—Are in their present position useless and dangerous; useless, because they are too short to reach the ground when the horses are put to—and dangerous because they cannot be put up or down unless a man gets under the limber, or puts his arms between the spokes of the wheel,

Digitized by Google

and if one of them should become loose whilst the gun is in motion, it would swing against the horses heels, and in all probability cause serious accidents. They should be removed to their old place, under the off shaft.

Mode of Packing 6 *pdr. Spherical Case objectionable for the following reasons, viz.*..—1st. The partitions for the shot are so deep and small, that it is very difficult to get a shot out—and much time is occupied in doing so.

2d. In endeavouring to get a shot out the Fuze is very liable to become loosened, as taking hold of it is the readiest, indeed almost the only way of getting the shot out. The Committee will (I have no doubt) be able to suggest some plan to rectify this objection.*

Partition Boards between the tiers of Shot.—These are not made of sufficient strength, and are constantly splitting—each board should be strengthened by a small band of copper where the shot rests. Those made of Deal stand pretty well, but those made of red Cedar and of Teak, split immediately.

Axletree Nuts.—These will I fear be found a serious evil, particularly in situations where Batteries have to be taken to pieces; and put up again in a hurry; for should the nuts of one carriage become mixed with those of another, it would take hours to find out, and fit the right ones. To disembark a Battery fitted up with these nuts in face of an Enemy, would I conceive be next to an impossibility; or at any rate it would be attended with very great delay and sacrifice of life. In my opinion this is a question of such vital importance to the best interests and renown of the Regiment, to which I have the honor to belong; that I trust the Committee will investigate it thoroughly; and if what I shall hereafter state is found to be correct, they will, I hope, use their best endeavours to have these complicated and dangerous screws and nuts discarded, and cause the simple linchpins and washers which have befriended us for so many years, to be taken into favor again.

The following objections have suggested themselves to me against the continuance of these screws and nuts.

1st. Their liability to cause great delay and loss of life, when disembarking before an Enemy; from a possibility of

* Vide 3d objection page 282.

Digitized by Google

those of one carriage, becoming mixed with those of another.

2nd. The difficulty indeed impossibility when on service of replacing any, that may be lost, or broken. They cannot I believe be made at any of our Arsenals ; but only at the Gun Carriage Manufactory.

3rd. The injury liable to be done to the box of the wheel, by its working on the screw, should the nut be lost or broken, on the line of march.

4th. The uselessness of having spare ones with a Battery, arising from the great difficulty of striking the thread of each screw in the same place, so that not more than one out of twenty or thirty will fit more than the axle it was made for.

5th. The thread of the screw on the axle is very liable, to become injured when the nut is not on it, and also by endeavouring to screw other nuts than the right one on to it.

6th. A blow on the end of the axle is very liable to rivet the nut on, and it then becomes a work of time to take the wheel off.

7th. By the introduction of these nuts that useful part of our Drill, dismounting Gun and Carriages is rendered nugatory.

I have eight spare nuts with my Battery, all of which I have tried on both arms of two axletrees—but not one of them would fit, many of them would not screw on more than half way—others screwed home—but required the linchpin hole to be made at one of the angles ; or mid-way between an angle and the linchpin hole ; so that to ensure these spare nuts fitting more than one axle, they should have eight or ten linchpin holes, this would weaken them so much as to cause them to break with a very slight blow.

A smith was occupied exactly *one hour*, in trying the eight spare nuts on the 4 arms.

I have heard an advocate for these nuts say "you have only to bore another hole, or to file the thread of the screw for five minutes and they will fit any axletree" but it takes time to drill a hole through a thick piece of iron, and it is not in all situations, that we have our Artificers with their files, at our elbows.

Digitized by Google

One of the nuts of the 9 pdr. Battery which was sent up to Nuggur for me last year, broke on the way up, and the box of the wheel, as well as the screw at the end of the axletree were both injured.

I have no doubt but other objections in addition to those I have mentioned will occur to the Committee.

Splinter Bars.—The construction of these is faulty, two of those of the 9 pdr. Battery sent to Nuggur last year, and one of the 6 pdr. Battery sent to Poona in March last, were broken at the point where they are contracted in size, before they arrived at those Stations.

Inner handles of Ammunition boxes.—These are not made of sufficient strength at the hinge, most of them are little more than $\frac{1}{10}$ of an inch in thickness, and several of them are even less. From this cause they bend easily, and are liable to break and cause accidents.

Postscript to the above Letter, dated Poonah 26th Sept. 1841.

P. S.—Since writing the above, I have discovered that two more of the splinter bars of my Battery have broken, and of these I send plans, shewing where the fractures have taken place fig. 36. I beg leave to observe, that these breakages have occurred on parade without any rough work, and without kicks or any other apparent cause. In both of these splinter bars, the worst fractures are in the right arm, and it is not improbable that they may have been caused by the weight of the shaft horse in halting the gun, being thrown more on the outer than on the inner shaft, thereby causing the shaft to act as a lever to bear down the end of the splinter bar. The iron rods extending from the axletree to the splinter bar not of sufficient substance to afford any strength to the latter.

I feel fully convinced that these new pattern splinter bars are utterly worthless, and that they will not stand even the ordinary marches from station to station. Another very great objection to them is the quantity of work there is in them viz. shaping, moulding—six mortises and five large pin holes all through; these cannot be done by one carpenter under a *day and a half*, whereas a carpenter could make *two* splinter bars of the old pattern in one day the old ones also were very strong and serviceable, I never knew one of them to break on a Parade or on an ordinary march—and through-

Digitized by Google

out the campaign in Scind one only belonging to my Battery was broken—and that one was broken by the end of it striking against a projecting rock when going through a narrow pass. I strongly recommend that the old pattern splinter bar be resumed.

Additional objection by Captain Martin, to the mode of packing Ammunition.

Objection No. 3 to new mode of packing Ammunition omitted by mistake in my letter of the 22d September to the address of the Secretary to the Military Board.*

3d. The shot being packed in two tiers instead of in one, as formerly, is found to be very inconvenient, for the shot in the second tier cannot be got at, unless the partitions of the upper tier are first taken out—these partitions are very liable to be broken or lost when thus taken out; and should either of these circumstances occur, the upper tier of shot could not be repacked until new partitions were made up. These partitions cause much delay in taking a shot from the lower tier: and should one of them fall sideways into the space below, it would be almost impossible to get it out without breaking it to pieces. The two tiers of shot also render the carriages top heavy—particularly the bodies of the Ammunition carriages.

Report of the Permanent Select Committee of Artillery Officers, dated Bombay 28th January 1842, on the Defects in the New Pattern Carriages.

In reply to your letter No. 2547 of 1841, under date 9th October, with its accompaniments from Captain Martin, commanding 3d Troop Horse Artillery, pointing out certain apparent defects in the new Indian pattern Field Carriages; We have the honor to state for the information of the Military Board that having taken this subject into consideration, availing ourselves at the same time of the experience of Captain Leslie commanding 1st Troop, who has been for many months on actual Field Service with a Battery of this pattern.—We beg to annex our opinions, viz.

Copper Magazine.—Copper Magazines are an useless expense, much time is lost in having Copper Magazines: the Canvass Pouches are much more handy, can be taken out with ease, the Ammunition quickly served from them, they

* Page 279.

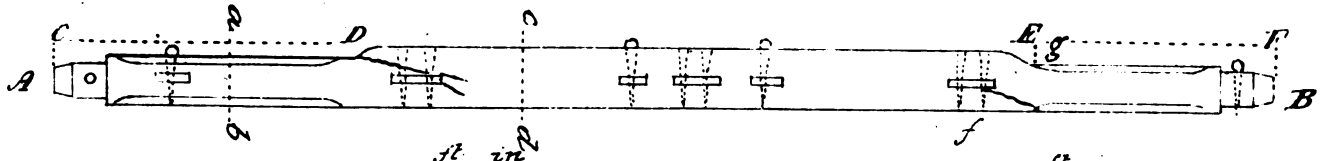
Digitized by Google

Miscellaneous.

Fig. 36

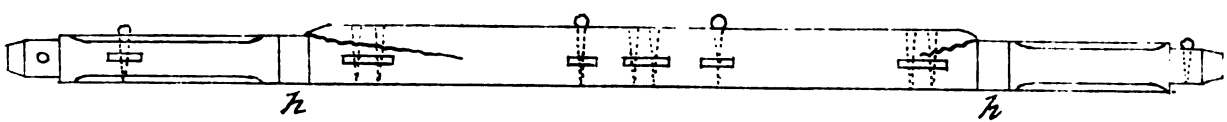
Front View of two Broken Splinter bars of the new pattern belonging to the 3rd Troop Bombay Horse Artillery

No 1.



	ft.	in.		ft.	in.
AB	6	3½	c d	0	4
CD	1	7	f g	0	2½
EF	1	1½	h.h. iron bands from axletree		
a b	0	3			

No 2.



Digitized by Google

Digitized by Google

do not encumber the Limber boxes being removed from over the shot when required : are easily transported across rivers : they preserve the cartridges sufficiently well : with the above view and fully concurring in the correctness of Captain Martin's practical remarks, we recommend the abolition of the present Copper Magazines and there-introduction of the painted canvass pouch formerly in use, two will be required to each Ammunition box, also to revert to the old system of packing in single tiers.

Lids of Ammunition Boxes.—We concur in Captain Martin's remarks and recommend that the lids of the Ammunition boxes be stuffed, the sheet copper over the lids to be dispensed with.

Long joint Hinges.—Long joint hinges such as formerly in use, to be again introduced.

Lids of small store Boxes.—Lids of small store boxes to be made in one piece, for reasons assigned by Captain Martin.

Perches.—The Committee would recommend a shifting perch, and Captain Martin's suggestions being attended to

Resting Bars.—Resting Bars should be placed under the off shafts.

Mode of Packing 6 *Pdr. Spherical Case.*—When the Copper Magazines are abolished as now recommended ; the shot and shell can be packed in one tier and sufficient room given to enable the gunner to take out the shot.

The Committee consider it advisable to revert to the former dimensions of Limber boxes viz. interior measurement,

Length	*Breadth*	*Depth*
19½ Inches.	17 Inches.	14½ Inches.

to enable every calibre easily to be packed in the same sized box.

Partition Boards.—Partition Boards should be strengthened and made up of Deal.

Axletree Nuts.—The objections brought forward by Captain Martin are so powerful and valid, and militate, with others which have come under the immediate notice of the Committee, so strongly against the utility and efficiency of the Ordnance branch of the Army, that the Artillery

Digitized by Google

Select Committee consider it their duty earnestly to press on the notice of the Military Board, the necessity of immediately discontinuing so dangerous, useless and expensive an article of Ordnance equipment, as axletree nuts with screws.

The Committee further fully concur in Captain Martin's remarks as to the evil done to the drill of the Artillery Corps, by the introduction of axletree nuts, thereby rendering nugatory that useful drill for mounting and dismounting gun and gun carriages; their liability to cause great delay and loss of life when disembarking before an Enemy, from a possibility of those of one carriage becoming mixed with those of another (no two nuts fit the same axletree arm as reported in Committee proceedings No. 2 of 1841, dated 11th January 1841) an objection so weighty as to call for their immediate abandonment: under these circumstances the Committee recommend the re-introduction of the washer and linchpin: the axletree arms to the carriages to be quite smooth, of the same size as that in the platform cart introduced by Captain Stanton, Agent for Gun Carriages, and recommended for adoption by the Artillery Select Committee in their letter dated 23d June 1841, No. 16.

Splinter Bars.—The Committee have reported their construction faulty, and recommended the introduction of another description as per letter No. 34, dated 29th December 1841.

Inner Handles of Ammunition Boxes.—Inner handles should be made stronger.

Should the Military Board concur in the above suggestions, we would recommend that the proposed alterations be carried into effect in all future constructions.

Extract from Captain Whitlie's letter to the address of the Adjutant and Quarter Master Artillery Scind, Sukkur, dated Camp near Kurrachee, 13th November 1840.

"It would also appear that a uniform guage of screw has not been used in forming the screws at the end of the axletree, and the nuts with washers instead of fitting any axletree arm were also all separately marked for each particular wheel, and the spare axletree nuts which are without any marks will not fit any arm to which they may be applied, conceiving that it must be intended, there should be the

Digitized by Google

strictest exactness in the axletree arms of all the Battery as well as in the axletree nuts, it has occurred to me deserving of being brought under Major Lloyd's notice, that in future equipments their object may be ensured more readily."

Extract from Artillery Select Committee Proceedings No. 2, *of* 1841, *date* 11*th January* 1841, *on Captain Whitlie's letter dated* 13*th November* 1840, *Camp near Kurrachee.*

"The guage of all the screws is uniform as is evident by the nuts going on any arms, the true cause which operates against nuts fitting all arms indiscriminately, viz.

"The uncertainty or rather impracticability of striking the thread of the tap in precisely the same place in any two axletree arms or nuts, and which is rendered more difficult from the coarseness of the thread."

"The difference of $\frac{3}{10}$ of an inch in the position of the first strike of the thread in any two nuts would prevent their fitting the same axletree arm; and again a similar difference in the strike of the tap of any two axletree arms would prevent a nut fitting both.

Dissent of Captain E. STANTON, *dated Colabah,* 4*th February* 1842.

Copper Magazines.—These I consider most valuable particularly for campaigns beyond the Frontier or at Stations remote from Ordnance Depôts as they undoubtedly retain cartridges in high preservation. There is a leather strap round each Magazine and when expedient it can be taken from the Ammunition box and carried; and without any danger of the contents being injured in wet weather.

I have known cartridges in this country much injured by damp during the monsoon and the bags by the attacks of insects; the Copper Magazine is a preventitive for both.

These have long been used by the Madras Artillery with success; a pouch is doubtless handy at a Field day, but to me the object of paramount moment is to ensure Batteries going into action with good serviceable Ammunition, a Battery may look perfection by hurried fire on parade but be powerless before an Enemy.

Digitized by Google

Lids of small Store Boxes.—They are strong and serviceable and making the lids in one piece will detract from the strength of the boxes and throw the lids when open, too near the Ammunition boxes, I consider this box ought to be covered with canvass in the manner the Ammunition boxes are covered—or a strip of leather tacked on to prevent wet entering. Two Ammunition Pouches could be furnished for the near, or off box of each gun limber, if necessary, and these filled from the Magazines as required.

Perches.—The present Perch is strong and substantial and not liable to break, and is easily detached from the waggon body, I formerly suggested that the Perch should be 6 inches square with a flat bar of iron underneath and false pieces put on at each side to support the boxes, and this I suggested knowing the difficulty at remote Stations or on Field service of getting a piece of timber when finished 10 inches in width, 6 inches in depth, and 118 inches in length, to replace a broken Perch—vide my letter No. 135 of 21st July 1840—to the Secretary to the Military Board. The Perch proposed by me was no departure from the present pattern, further than having it in one large and two small pieces with a plate of iron underneath. The Select Committee threw it out.—I am not aware of any new Perch having broken, some at first were made by one of my predecessors of two pieces of wood, these may have broken.

The body of the new waggon is not fitted for the old pattern shifting Perch, for the weight in these waggons is thrown more forward and consequently a strong substantial Perch is required.

The old pattern Perches were always breaking and the new Perch surely ought not to be condemned without a trial—If the Perch is altered to a shifting one the whole frame of the waggon must be altered.

Mode of packing Spherical Case Shot.—I conclude this applies to all descriptions of shot. The present Ammunition boxes can be arranged so as to prevent any difficulty in taking out shot, the only difficulty is in the 6 pounder Ammunition boxes, the manner the muster boxes from Bengal are divided is simple, and no obstacle in taking out the shot, the small partitions in these boxes were introduced from some desire to have each description of shot separate, on a repre-

Digitized by Google

sentation from the late Agent for Gun Carriages I think, and passed by a Committee of which I believe, I was a Member, and as it has not worked well the Bengal system can be reverted to, if necessary, and which will admit of partition boards being strengthened.

The present Ammunition boxes are suited to the frames of the carriages, and the shot of low calibres is low in the boxes, consequently there can be no reasonable fear of limbers and waggons of Horse Artillery being top heavy, and Foot Artillery never making rapid movements it is of no importance the weight being a little higher.

Partition Boards.—Deal plank without giving timely notice cannot be procured, and I consider Cedar equally good, at the first introduction of this wood none highly seasoned was available and it has not had a fair trial.

Axletree Nuts.—The objections to these are, according to my opinion, much overdrawn, I am however an advocate for having every part of a Gun Carriage as simple as possible, and am therefore opposed to the nut to screw on to the axletree arm, I should like to have a plain arm as recommended with a washer and linchpin, the disadvantages of the present nuts are visible to every Artillerist ; I however see nothing dangerous in them. It is not necessary to screw on the nuts before commencing firing, the washer and linchpin are sufficient and I cannot enter into the views of danger on embarkation and disembarkation before an Enemy, and how often is it a Battery is required to be embarked and disembarked under such circumstances. When a carriage is taken to pieces the nuts ought to be replaced to protect the axletree arm screw if needful to be kept off, they ought to be put in the Limber Store Box.

The drill of mounting and dismounting I consider to be the most unimportant of all the Artillery Drills, the object is to make the men good practical Artillerymen and frequently mounting and dismounting guns and carriages is very apt to strain and injure men without any beneficial effect, I know this from my experience when Adjutant to the Artillery at Ahmednuggur in 1830-31-32.

Inner Handles of Ammunition Boxes.—There is a hinge to these to enable the handle to fold down, and to strengthen them is difficult without making the handles clumsy and

Digitized by Google

heavy, if there must be an alteration, I think it would be better to have the handles without hinges, the nuts or handles now in use screwed tight would make them fixtures and a strong ring where the hinge now is for lashing the box down to the splinter bar, or a lashing eye similar to the one in front of the Limber Ammunition box, put to the side of the box might answer the purpose better.

General Observations.—I have deemed it my duty, with all deference for the opinions of my colleagues, to record distinctly my dissent to the Report on the axletree nuts, although anxious to have the axletree arms similar in all respects, to the arm of the new pattern axletree for Platform Carts as recommended by Select Committee in letter No. 34 of the 29th December 1841, indeed I am sensible every part of an Ordnance Carriage ought to be as simple as possible, and the disadvantages of the present nuts are numerous and visible to every experienced Artillerist; they can however be fitted to any arm by drilling a new linch hole: the thread of all the screws being the same, vide appendix.

The present pattern carriages of which about 128 of sorts are in use will improve every year; arrangements having been made to keep up a large stock of well seasoned material. The heavy complaints have all come from the 3d Troop Hore Brigade, and as other Batteries are in use, and others are likely to be issued, it would in my opinion be well hereafter to call for further reports on them. In my letter (as Agent for Gun Carriages) No. 73 of the 14th May 1840, to the Secretary of the Military Board I particularly urged the necessity of having the new pattern carriages tried in every possible way, in order that any defect in construction, material or workmanship, might be brought to light—and I feel it would be an advantage if the Troop at Poona had one Carriage and Limber in charge for trial to be worked with the old pattern carriages.

Digitized by Google

SCALING LADDERS.

CONSTRUCTION AND APPLICATION BY UBIQUE, DATED 5*th May* 1838.

In reading the generality of accounts by escalade, I remark—

1st.—The defect in the construction of the ladders employed, which admitted of no prompt means of repairing them on the spot, or of varying their length at pleasure, so as to adjust them to the height to be surmounted, and which can only be ascertained at the very moment when the ladders are being applied.

2dly.—The want of means of preventing the assailed, standing on the parapet, from overthrowing the ladders.

3dly.—The paucity of ladders employed.

With respect to observations, I will cite one or two examples.

At the first assault on Cristoval, an outwork of the fortress of Badajos, 'the forlon hope,' says Napier, 'finding the opening impracticable, was returning with but little loss, when the main body which had been exposed to a flank fire from the town, as well as a direct fire from the fort, came leaping into the ditch with ladders, and another effort was made to escalade it at different points; the ladders were too short (viz., 15 feet, while the front escarpe was 25 feet: see *Jones's Journal*), and the garrison, consisting of only seventy-five men, besides cannoneers, made so stout a resistance, that the assailants retired with the loss of more than a hundred men.'

In the escalade of St. Vincente bastion, Badajos, 'when the foremost men succeeded in rearing the ladders, the latter were found too short, for the walls were thirty feet high. The assailants having discovered a corner of a bastion where the escarpe was twenty feet high, placed three ladders under an embrasure which had no gun, and was stopped only by a gabion; some men got up, but with difficulty, for the ladders were still too short, and the first man who gained the top was pushed up by his comrades, and then drew others after him.'

For the surprise of Almaraz, twelve ladders, sixteen feet long, were carried with the corps, but 'it was doubtful if the scaling ladders, which had been cut into halves, to

Digitized by Google

thread the narrow turns in the precipitous descent, would serve for the assault.'

Now, as regards the nature of the ladders employed at these sieges, I learn from officers who were engaged in the escalades (for I am sorry to say I cannot speak from the evidence of my own eyes), that the several ladders were constructed in one length, and not formed by a junction of one or more ladders; and that this was the case appears evident, for had each ladder consisted of a combination of ladders (such as I shall speak of), the complaint of 'too short,' at Cristoval and the St. Vincente, would have been immediately remedied on the spot, by dismantling one ladder in order to lengthen others with the detached pieces. Nor would Hill's corps at Almaraz, with such a construction, have had occasion to cut their ladders, and thereby endanger the success of the assault.

It is, therefore, evident, when ladders are constructed of one unalterable length, that they must frequently prove perfectly useless in an assault. The difficulty, too, of procuring on service spars of the length requisite for long ladders, is also an objection to them, and this difficulty must tend to cause a paucity of ladders; but if, in order to supply the deficiency of adequate timber, the several cheeks be composed of two pieces spliced together (even, if for security, the splice of the one cheek, as it should be, do not correspond with the splice in the other cheek, and a round be made to pass through both portions of the splice), the ladders will be very rickety and insecure; moreover, long ladders are difficult of transport with an army, and are further objectionable.

First, because the men who carry such heavy ladders are obliged to part with their arms, as was the case at Badajos.

Secondly, because, when long ladders are lowered into the ditch, from the sloping position to which their length naturally subjects them, and in which position they are least calculated to bear weight, they run great hazard of being broken by men crowding upon them, in their eagerness to get into the ditch.

Thirdly, because of the difficulty in rearing long ladders, and the exposure to missiles thrown from the ramparts, to which the men would be subjected when so engaged in the middle of the ditch, but from which they would

Digitized by Google

be in a measure secure, if employed in erecting the ladders close under the wall, in the manner I will hereafter point out.

Now as there are comparatively few officers of the line who have an opportunity of observing the ladders used in the Engineer department at Chatham, or of partaking of the practical instruction of escalade which is occasionally afforded to the troops in that garrison; and as officers thus uninstructed may be placed in situations where no engineer officer is present to construct proper ladders, or direct the escalade (the records of the Peninsular sieges show how conspicuous engineer officers are on such occasions), and must, consequently, be thrown entirely upon their own resources, I will venture to devote the rest of this paper to giving instructions, sincerely hoping that the page in the *United Service Gazette* where this will appear may recur in time of need to some soldiers so placed, or to some sailors or marines whose curiosity may (as has so often been the case) induce them just to take a peep into a martello tower, or other work on an enemy's coast.

Old General Congreve's ladders, with which some thirty years ago I was taught escalading in the Woolwich repository, and which nature of ladder is, I believe, now made use of at Chatham, are in length, 6 feet; breadth, 1 foot 10 inches at top, 2 feet 2 inches at bottom; cheeks, about 2½ inches by 3½ inches throughout; rounds or steps, one foot apart; weight, 34lbs.

These ladders, so light and handy as to be easily carried by one man, together with his musket, can at any moment be united, so as to form any required length, by means of a single strong iron staple or loop fixed to the foot of each cheek, inside, through which the head of another ladder is to be passed, until it rest against the first round or step, to receive which the upper part of the cheeks of every ladder are hollowed out with a semicircular notch; so that ladders thus joined, overlapping each other about twelve inches, having no play, and being secured by a short lashing, if necessary, passing from the bottom round of one ladder to the top round of the next ladder, are perfectly firm; for you will observe that the head of each ladder is for this purpose constructed just so much narrower at the top as will admit its lying within the feet of another ladder.

When ladders are constructed of these dimensions, there

Digitized by Google

can be no difficulty in procuring timber for an abundant supply of ladders ; for if a wood be not at hand where it can be cut, the beams and joists of one or more houses dismantled for the purpose (on such occasions one must not be over scrupulous) will afford ample materials.

Having thus given directions for the construction of ladders, we will now come to directions for the application of them. But here I must observe, that I care not whether this or that suggestion of mine which I now write, or which has been already published in the *United Service Gazette*, in my ' Reveries,' be adopted or not, my earnest desire being solely to draw the attention of the commissioned and non-commissioned soldier to those professional practical subjects which, much to be regretted, form no part of the regular discipline of the Army at large ; hoping, as I do, that when placed in emergencies, and having been previously led to canvas these subjects, and having consequently, formed some matured opinions respecting them, they may be prepared to act.

If then, the execution of an escalade were entrusted to my directions, I would take care that those officers and men destined for the duty of fixing the ladders should receive some previous instruction as to the method of application and mounting them, if it were but for half an hour at the depôt previous to their marching for the assault. Indeed, every individual to be engaged in the assault should have his particular duty specifically detailed to him, and the topography of the place to be assaulted clearly explained to him ; for the success of a tragedy depends in a great measure upon each individual being perfect in the part he is to perform, that his whole energies may, unabstractedly, be devoted to giving full effect to it. It may appear strange, because I believe not according to the usual order of things, when I say I would not cause the party to be preceded by axe-men, or those bearing ladders, because it is too much to expect that men encumbered with heavy ladders, and deprived of their arms (or even of carrying the six foot ladder with their arms, which, from the nature of their occupation, they feel they cannot use), will steadily advance if a fire be opened upon them when they have no covering fire. We may see the effects of such an arrangement in the attack of St. Vincente bastion. ' His troops (General Walker's brigade) had advanced along the banks of the river, and reached the French guard-house, at the barrier gate, undis-

Digitized by Google

covered, for the ripple of the waters smothered the sound of their footsteps ; but just then the explosion at the breaches took place, the moon shone out, and the French sentinels, discovering the columns, fired. The British troops immediately sprung forward under a sharp fire of musketry, began to hew down the wooden barrier at the covered way, while the Portuguese, being panic-stricken, threw down the scaling ladders.'

I would, therefore, first advance a strong firing party to the crest of the glacis, or the edge of the counterscarpe (the counterscarpe is the outside wall of the ditch, the escarpe is the inside wall of the ditch) to lie close until their services be required, if a surprise be intended, or at once commence a fusillade to keep down any fire from the rampart, directing their attention more especially to any part of the work which may flank the wall to be escaladed, and by a concentrated and incessant fire upon any embrasures that may be animated, render it impossible for the gunners to work their guns ; and under cover of this party I would advance the ladders and the rest of the escalading party, but not with the ladders compounded to the full length required for mounting the escarpe, but only having a few of a length just sufficient to make the descent into the ditch (say a ladder compounded of two Congreve's, equal to eleven feet), the rest of the party carrying the single Congreve ladders (and several ropes, ten or fourteen yards long, to be applied as we shall presently see). As these men with ladders get into the ditch they must move quickly up to the wall to be escaladed, and those who have previously been told off for the purpose (leave as little as possible to be done in a hurry-scurry, and have spare numbers sufficient to fill up casualties allotted for each duty) must now raise their ladders so as to enable other men who have been assigned for the purpose to ship second ladders into the feet of the ladders raised up, through the iron staples previously described. The ladders thus compounded are again lifted up from the ground, so as to ship other ladders in like manner, and so on until the heads of these ladders thus prolonged shall be about three or four feet above the wall, that the escaladers need not crawl from the ladder on to the top of the wall, but be enabled to step firmly and erect from the ladders, and be instantly ready for single combat.

The fire produced by the discharge of musketry will afford sufficient light to enable the men at night to see how to

Digitized by Google

ship one ladder into another, and the raising of the ladders will be facilitated if lifting-bars, about three or four feet long be provided, with a couple of hooks in them to be applied to the lower round of the ladder to be raised from the ground, while another ladder is being shipped.

When the objections are considered which I have noted in the fifth paragraph as applied to long ladders, and which are equally applicable to the simple six feet ladders, if compounded previously to entering the ditch, I think that many of your readers will be of opinion with me, that the plan I have detailed (the one taught at the Woolwich repository, although different, I believe, from that practised at Chatham) is the most expeditious, and the least hazardous.

As much depends upon the speedy and proper application of the ladders, they should be placed under the particular direction of officers of rank, especially of those of known authority of manner, with steady non-commissioned officers not required themselves to mount the ladders, who must take care that they are not placed with much slope, for they will then be weak; nor very much approaching the perpendicular, for they will then be difficult of ascent, and be easily overturned. Also that they may be placed as close together as they conveniently can be; and that the men be prevented crowding the ladders, which so far from expediting the ascent, will delay it, especially if any casualty occurs on the ladder, independently of the great risk of breaking the ladders. Nor should one or two ladders alone be suffered to be raised, the chance of success being greater according to the number applied at the same moment, or as nearly together as may be.

With respect to observation 2—An enemy who feels confident in the superiority of his commanding position (although confidence and success generally are on the side of the assailants, for Marshal Saxe justly observes, that the defenders of entrenchments generally abandon them at the very moment when the advantage which they have is on the point of being shown, viz., the moment of the assailants crowning the parapet) will boldly advance, and overthrow the ladders as soon as they are reared, or contrive, under cover, to capsize them by means of poles with hooks in them, or by ropes with nooses, as was the case, for instance, at the assault on the castle of Badajos, where the historian says —' Meanwhile his troops (Picton's division), spreading

Digitized by Google

themselves along the front, reared their heavy ladders, some against the lofty castle, some against the adjoining front on the left, and, with incredible courage, ascended amidst showers of heavy stones, logs of wood, and bursting shells, rolled off the parapet, while from the flanks the enemy plied his musketry with a fearful rapidity, and in front with pikes and bayonets stabbed the leading assailants, or pushed the ladders from the walls, and all this attended with deafening shouts, and the crash of breaking ladders, and the shrieks of crushed soldiers answering to the sullen stroke of the falling weights. Still, swarming round the remaining ladders, these undaunted veterans strove who should first climb, until all being overturned, the French shouted victory.' I need not go on to say how the heroic Colonel Ridge' and the gallant 'grenadier officer, Canch,' in their turn shouted victory; but I will add, that a brave French officer was seen to advance and throw down the first ladder, and that, to prevent a repetition of this, the British soldiers crowded the next ladder so thickly, to keep it down, that, unable to bear the weight, it broke to atoms.

To guard against this, a pair of guy ropes must be fixed about 6 feet from the top of each ladder, previously to being erected, where they cannot well be cut by those on the rampart, and then stretched out on each side of the ladder like the shrouds of a mast, and held on by men standing close to the wall. All efforts from above to overturn the ladders will then be in vain (I believe this plan is not, or was not, adopted at Chatham a year or two ago). These guy ropes will also be found of great use in rearing long ladders, and enabling you to clear the head of the ladder from the cordon (a row of stone built in, and projecting beyond the wall two or three feet, to render escalade more difficult), or to get the ladders clear of fraizes (palisades laid horizontally or with a slope, and projecting the top of the wall about five feet). But whether ladders be compounded on the spot, or be previously joined to the full length, guy ropes should be used; in the latter case the guy ropes had better be fixed, and stretched, and fastened along the cheeks of the ladder before descending into the ditch.

These said fraizes are very nasty things to meet with, stuck full too, as they often are, of tender-hooks, and as they are placed just so far apart as to prevent men creeping through them, and not sufficiently near to prevent the cheeks of a ladder from passing between them, it will be well

Digitized by Google

to consider how these obstacles are to be dealt with where the fire of artillery has not made an opening among them.

One way that naturally suggests itself is by sending men up the ladders with axes to cut the fraizes away; but just consider what a hazardous operation that would be if the enemy were on the alert, and how difficult, even under more favourable circumstances, for a man to be hewing at a stout piece of timber above his head, and when the proximity of the fraizes would prevent his axe taking a sweeping blow; consider the time, too, that would be required, and how the noise of the axes would wake a slumbering enemy. What I would do, anticipating the obstacle, would be this—I would lash across the ladder, nearly at the top, a bar of wood about four feet long, and about 6 feet lower down I would lash another bar; then to these cross bars, on the outside of each cheek of the ladder, I would fix a board of a foot in breadth. This additional breadth given to the cheeks will prevent the ladders passing between the fraizes, and as some of the fraizes may probably prove rotten, and otherwise afford a very insecure landing, it would be well for the leading men to carry a fascine (bundle of faggots) to throw on the fraizes to make a platform or landing-place to step on from the ladders. And should the assaulting party be unexpectedly obstructed in their advance by palisades in the ditch, and should fear disturbing the enemy by cutting them away with hatchets, hang up a ladder lengthways on the palisades, forming as it were a top rail. A few pocket handkerchiefs as a *pis aller* will serve to fix them: the scaling ladders may then be applied, resting on the top rail, and the palisade be easily surmounted.

I will now notice my third observation, viz., the paucity of ladders usually employed.

It would be a waste of time to prove that if the whole face of a bastion, or a curtain throughout its length, were covered with ladders, that the chance of success of an escalade would be greater than if only three or four ladders were erected against the wall; for not only would more time be consumed before the whole of the storming party had gained a footing, but the enemy being able to converge a greater proportion of fire, or force upon three or four ladders than upon a more extended front, the assailants would be under greater disadvantages, especially as they could afford little or no reciprocal aid. I take it that the advantage gained by an

Digitized by Google

increased number of ladders is not merely in the ratio of the numbers of ladders, as 1, 2, 3, 4, 5, but that the advantage increases in something like the progression of 1, 3, 5, 7, 9.

Now we have seen how few ladders were employed at St. Vincente bastion and at the castle of Badajos; and it may not be too much to venture to say that had the opposition been in greater force or more vigorous at those points from the inadequate number of ladders to the importance of the enterprise a different result would have followed. The light, and fourth division to storm the breaches, only entered the ditch with 'five ladders;' now had the supply of ladders been more liberal, attempts might have been made on some parts of the work adjacent to the breach, which possibly might have been successful or have drawn off the attention of those who were defending the breach.

It appears to me that the operations of a siege in themselves, naturally slow and oftentimes retarded by weather and other unforeseen circumstances, might frequently be considerably shortened by resorting to escalade, and also that distant garrisons who are reposing in the fancied security of their works might more often fall an easy prey to a *coup de main*, were they to be assailed with scaling ladders abundantly supplied, and placed in the hands of men properly instructed in their use. Burgen-op-zoom may be instanced to shew what may be done. Surely an assault by escalade, where you can select your point of attack, cannot be a more hazardous operation than the storming of a breach where your efforts are confined to a small space, and to which the chief attention of the enemy is directed; where the ascent is often difficult, and where every impediment, which the ingenuity and the resource of the engineer can supply, is placed in your way; often, too, where a retrenchment enables the enemy in perfect security to direct a powerful, constant, converging fire upon the spot. One of our own engineers, of practical experience, thus expresses himself on the storm of a breach—'If the enemy stand firm, it is nearly impossible to carry a breach without mounting to it regularly formed.' The descent into the ditch, whether by ladders or by jumping down, must break all order in the troops, and therefore it should never be attempted against a place with a revetted counterscarpe (that is, a wall of brick).

If when a siege is advancing by its regular steps, and the enemy are confined within the body of the place, and the

Digitized by Google

breach commenced or even its situation clearly indicated, we may form some idea of the success which would attend an escalade made in an unlooked-for direction, while the garrison were consoling themselves in the belief that the breach was not practicable; if an abundance of ladders, secretly prepared at a distance, and suddenly conveyed to the camp shonld be employed in an assault; for the engineer before alluded to (see Jones' Journal) observes, respecting the siege of Badajos—'It is a singular circumstance perhaps without its paralled in the events of sieges that an army with a powerful artillery, after 20 days' open trenches and having formed three practicable breaches in the body of the place, should fail in the assault of them at the very moment that two divisions of it were employed in different parts and each succeeding in forcing an entry by escalade over the walls.'

Imagine, too, the effect of some choice battalions, directed by an intrepid commander, whose 'come on my lads' runs through the ranks like an electric shock, (your 'go on my boys,' your 'simpering sybarites,' your 'teasing officers,' and your officers who look more after their own *batterie de cuisine*, than the feeling of the soldiers' camp kettles, won't do) marching some ten or a dozen miles to a camisado, with five hundred of the brigade carrying each a Congreve ladder of only 34lbs. weight, capable of forming one hundred compound ladders of twenty-six feet long (I have shown that there cannot be much difficulty in procuring sufficient timber to make ladders of these dimensions), with a proper proportion of men equipped as 'boarders,' and having timed the march so that under cover of darkness they may escape the brunt of the enemy's fire (should the surprise not be complete), and just reach the ramparts as the sable curtain of night is being drawn up, that they may clearly see the stage on which the tragedy is to be performed.

Indeed, if one could only conceal one's march to within one or two hundred yards of the enemy, I should even prefer taking the bull by the horns in open day; for my own part, I confess, I do not like night work. I have seen some nocturnal affairs of a very nasty nature. A man startles at his own shadow in the dark; and at the least alarm men's fingers, by instinct, go to their triggers. I was once present when the discharge from the pistol of a single vidette of the enemy, at our advance, caused two regiments, with a couple of six pounders between them, moving through a wood, for a night

Digitized by Google

surprise, to open their fire, positively, in column of subdivisions in which they were marching. In the dark, the example of the brave is lost; while the timidity of the skulker is infectious. Nocturnal attacks are generally attended by blunders self-destruction, or failure.

I will add, that the knowledge of the effects of gunpowder seems entirely to have diverted our thoughts from the mode of warfare of the ancients; thus the combat with sword by footmen is lost sight of (unquestionably so as to the armature of our infantry, notwithstanding the Anglonean instruction they receive). And the buckler is wholly thrown aside. But I think we may, on some occasions, try back with an advantage, as I have endeavoured to demonstrate in the armature I have suggested for the leaders of an escalade. And I conceive that the shield might be employed with great effect at sieges, to cover your riflemen, who might then, in comparative security, beset the enemy's embrasures like a swarm of hornets. The boards ripped from the flooring of a good-sized house, if nothing else can be procured, would make a large quantity of musket proof shields, 4 feet by 2½, formed with props to make them stand on the ground, and having a small port-hole in each, through which to point a rifle or musket; for we know that the aim is more steady when a man only hears the buz of the flying lead, and knows it cannot sting.

ROPE AND BAMBOO SCALING LADDERS.—FIG. 37.

The ladders are 22 feet long, 18 inches wide at the top and 27 inches wide at the bottom. The bamboos are kept asunder by 3 spunge staves, or any other convenient pieces of strong wood passing through them, and fastened with wooden pegs on the outside. These staves are shouldered on the inside, to keep the bamboos from slipping inwards. The steps are 15 inches asunder, and are made of 1½ inch coir rope, which should previously be well stretched by a windlass, or some other similar method; this prevents the steps from becoming loose, or swagging in the centre, which they are otherwise apt to do. The rope is passed twice across each side of the ladder, and fastened to each bamboo, with a double hitch, which is then firmly secured above and below with spunyarn; the rope should be pulled as tightly as possible when fastened on the bamboos. The four pieces of rope so stretched and fastened, are then strongly lashed together with loose coir, thus forming a firm, compact, and

Digitized by Google

very strong step. The bamboos are tightly lashed with spunyarn for 10 or 12 inches above and below the insertion of the staves, which adds materially to the strength of the whole structure, whilst it effectually obviates all chance of accident from the bamboos splitting, where they have been cut to receive the staves.

Weight of the ladder 74lbs, and two are carried by two coolies, or three at most.

DIMENSIONS AND MATERIALS FOR MAKING UP SCALING LADDERS, AS APPROVED BY THE MADRAS MILITARY BOARD, 6TH DECEMBER, 1831—FIG. 38.

6	Bamboos	16 feet long	Diameter from $3\frac{1}{4}$ to 4 inches.
3	„	22 „ „	
26	„	$5\frac{2}{3}$ „ „	Diameter from $1\frac{1}{2}$ to 2 inches.
9	Rolls	of spunyarn.	

SUBSTITUTION OF SPHERICAL CASE SHOT, BY MAJOR C. G. NAPIER, ROYAL ARTILLERY, DURING THE BATTLE OF WATERLOO.

"I beg leave further to state that before the column of attack gave way, I received the appalling intelligence that the case shot of the heavy howitzer was expended, and as I had no time to get a further supply from my spare ammunition cart, I directed my Subaltern Officer to fire shrapnell shells without fuzes, and as the heavy howitzer was advanced so as to bear on the left flank of the French column I attribute the pouring in of such a mass of musket balls, together with the splinters of the shells, at so short a distance as about forty paces, as the main cause of spreading such destruction in the Enemy's ranks, and I think I am borne out in my assertion by the following account of a French officer who was an eye witness of the same, who states as follows: "Buonaparte, whose resolutions nothing could change, thought the moment was arrived to determine the day: he formed a fourth column of attack almost entirely composed of his guard, and led on the charge upon Mount St. John, after directing his orders on every point to second this movement on which fate seemed to hang. Those old warriors entered the plain with their accustomed intrepidity, and courage was restored through the whole line. The guard made several charges, but was constantly repulsed, crushed by a terrible Artillery that each minute seemed to multiply. These in-

Digitized by Google

Digitized by Google

Miscell

Scaling

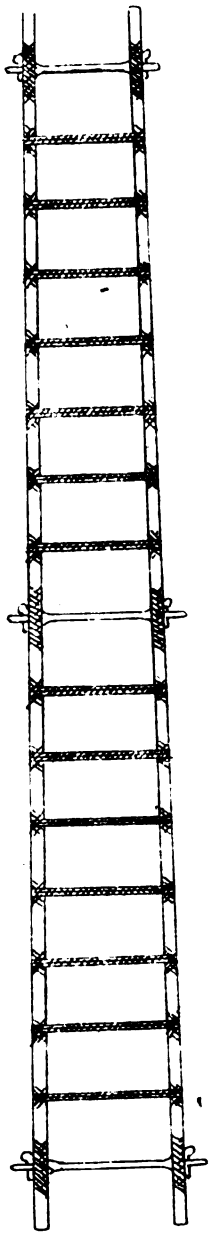
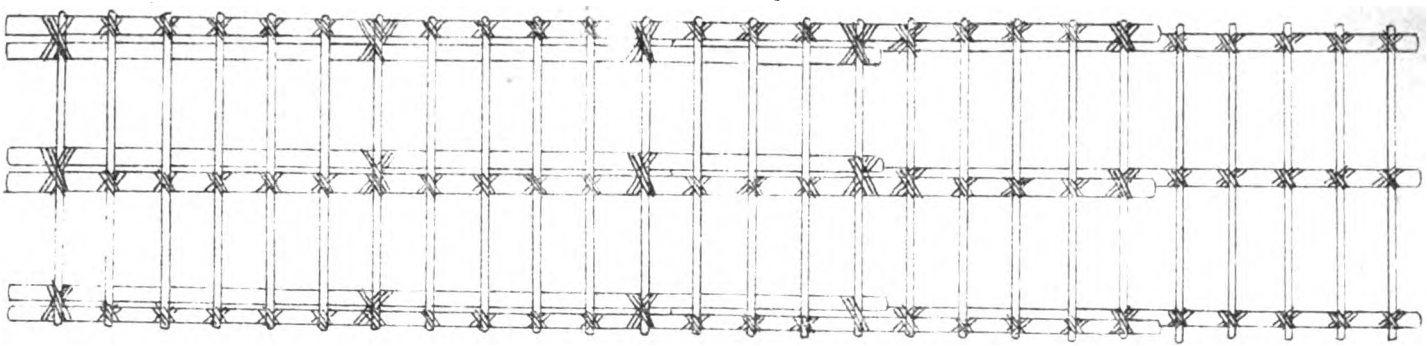


Fig. 37.
Rope & Bamboo

Digitized by Google

fig 38.

Muster approved by the Military Board



Digitized by Google

Digitized by Google

vincible Grenadiers beheld the grape shot make day through their ranks; they closed promptly and coolly their shattered files; nothing intimidated them; nothing stops them but death or mortal wound: but the hour of defeat had sounded! enormous masses of British Infantry supported by an immense Cavalry we had nothing to oppose to (for our own had already met its destruction) descend in fury, surround, and cry out to them to surrender. 'The guard never surrenders; if called on, it dies!' was the reply. No more quarter is given: almost the whole fall fighting to desperation. In vain Buonaparte for a last effort collected some battalions of the young and old guard, which had been least engaged, and led them on. All in vain! intimidated by the scene, and pulverized by the cannon, this feeble reserve was presently overthrown. The army, then spontaneously and all at the same time left its posts and spread like a torrent in all directions."

THE ILLUSTRIOUS GARRISON

Letter from Major General R. Sale, dated Jellalabad 16th April 1842; to T. H. Maddox, Esq. Secretary to Government Political Department.

Sir,—The relief of this place having been at length effected by the victorious advance through the passes of the Khyber, of the Army under Major General Pollock, C. B., I conceive that I owe it to the troops who have so long formed the Garrison here to address to you a Report, which may convey some notion of their conflicts and the severity of their duties, labours, and privations. It has before been made known to Government, that I reached Gundamuck on the 30th of October, 1841, under instructions from the authorities at Cabool, and there received intelligence of the breaking out of a terrific insurrection at the Affghan Capital on the 2nd November. My retracing my steps on that city was, in a military sense, impracticable, since the first inevitable sacrifice would have been of the lives of 300 sick and wounded, whom I could not have left in depôt with the treasonable irregulars at Gundamuck, whilst my cattle was unequal to the transport of my camp equipage, and my ammunition insufficient for protracted operations. In the position which I occupied, I could not absolutely command a day's provisions or even water, and should have been hemmed in on every side by hostile tribes, amounting to 30,000 or 40,000 men, part of whom might have seized Jellalabad and re-

Digitized by Google

duced it to ashes, or, holding it, have left me no alternative but a disastrous retreat towards Peshawur. I therefore came to the resolution of anticipating any movement of this kind, and by possessing myself of this city establishing a point on which the Force at Cabool might retire if hardly pressed, and restoring a link in the chain of communication with our Provinces. Two marches brought me, after a successful contest at Futtahabad, to Jellalabad. My breaking up from Gundamuck was followed by the immediate defection of the Irregulars there, the destruction of the Cantonment, and a general rising of the Tribes. I found the walls of Jellalabad in a state which might have justified despair as to the possibility of defending them. The enceinte was far too extensive for my small Force, embracing a circumference of upwards of 2,300 yards. Its tracing was vicious in the extreme ; it had no parapet excepting for a few hundred yards, which there was not more than 2 feet high. Earth and rubbish had accumulated to such an extent about the ramparts, that there were roads in various directions across and over them into the country. There was a space of 400 yards together on which none of the garrison could shew themselves, excepting at one spot; the population within was disaffected, and the whole enceinte was surrounded by ruined forts, walls, mosques, tombs, and gardens, from which a fire could be opened upon the defenders at 20 or 30 yards.

The garrison took full possession of the town in such a state on the morning of the 15th of November, and in the course of the day, the place and detached hills by which, on one side, it is commanded, were surrounded and surmounted by a force of not fewer than 5000 Insurgents. A general attack on the 14th of November, ridded us of these enemies, and a similar array brought against us a fortnight afterwards, was dissipated by a second sally, on the 1st of December. But we had seized the town having in our possession not quite two days provisions and corn for our men and horses, and beheld the arduous task before us of striving to render the works defencible, and collecting supplies for our magazine from the midst of a fanatical and infuriated people with very narrow means in the way of treasure to purchase them.

I appointed Captain Broadfoot, Shah Soojah's Sappers, Garrison Engineer, and Captain Abbott, of the Artillery, Commissary of Ordnance. Captain McGregor, Political Agent, gave me the aid of his local experience, and, through

Digitized by Google

his influence and measures, our Dawk communication with India was restored, and a great quantity of grain collected, whilst the unremitting, and almost incredible labours of the troops aided by the zeal and science of Captain Broadfoot, put the town in an efficient state of defence. Captain Abbott made the Artillery dispositions in the ablest manner, and used every exertion to add to and encourage our resources in the way of gun and musket ammunition, in both of which we were deficient for the purpose of a siege. Lead and powder were procured in and about Jellalabad, and a quantity of cartridges discovered in an old magazine, and thus the troops completed to 200 rounds per man. It is to be remarked that I might in the second week of November have marched upon Pesh Bolak, relieved from investment the Corps of Jazailchees under Captain Ferris, and with it operated a doubtful retreat upon Peshawar. But I felt it to be my duty to give support to the last moment to our Troops, struggling against their numerous enemies at Cabool, and maintain for them a point on which to retreat and rally if they meet with reverse.

On the 9th of January, I was summoned by the leaders of the Affghan Rebellion to give up the place in fulfilment of a convention entered into by the Political and Military authorities at Cabool, but as I was fully assured of the bad faith of our enemies, I refused to do this, and on the 13th received the melancholy intelligence of the disastrous retreat of our Troops from the Capital, and their annihilation in the Ghilzie defiles by the rigours of the climate and the basest treachery on the part of those in whose promises they had confided. Almost at the same time it became known to us, that the Brigade of four regiments marched to my succour from Hindoostan had been beaten in detail and forced to fall back upon Peshawur: my position was most critical, and I might, whilst our enemies were engaged in plundering the Force from Cabool, have attempted, and perhaps effected, though with heavy loss, a retreat across the Khyber; but I resolved, at all hazards, on not relinquishing my grasp on the chief town of the Valley of Ningrahar, and the key of Eastern Affghanistan so long as I had reason to consider that our Government desired to retain it. The discouragements of my Garrison at this moment were very great, their duties most severe, their labours unceasing, and the most insiduous endeavours made by the enemy to seduce the native portion of them from their allegiance. But their fi-

Digitized by Google

delity was unshaken, and their serenity amidst labours and privations unclouded. With reference, however, to the state of fanatical excitement and national antipathy which prevailed around us, I had been compelled as a measure of prudence to get rid, first of the Corps of Khyber Rangers, and next of the detachment of Jazailchees, and a few of the Affghan Sappers and a body of Hindoostanee Gunners, who had formerly been in the employment of Dost Mahomed Khan. Works had, in the mean time, been completed, of which the annexed reports and plans of Captain Broadfoot contain ample details. Generally, I may state, they consisted in the destruction of an immense quantity of cover for the enemy, extending to the demolition of forts and old walls, filling up ravines and destroying gardens and cutting down groves, raising the parapets to 6 or 7 feet high, repairing and widening the ramparts, extending the bastions, retrenching three of the gates, covering the fourth with an outwork, and excavating a ditch ten feet in depth and 12 feet in width round the whole of the walls; the place was thus secure against the attack of any Asiatic enemy, not provided with siege artillery.

But it pleased Providence on the 19th February, to remove in an instant, this ground of confidence. A tremenduous earthquake shook down all our parapets built up with so much labour, injured several of our bastions, cast to the ground all our guard houses, demolished a third of the town, made a considerable breach in the rampart of a curtain in the Peshawar face, and reduced the Cabool gate to a shapeless mass of ruins. It savours of romance but is a sober fact, that the city was thrown into alarm, within the space of little more than one month, by the repetition of full one hundred shocks of this terrific phenomenon of nature.

The Troops turned with indefatigable industry to the reparation of their walls, but, at the moment of the great convulsion, Sirdhar Mahomed Akbar Khan, Burukzye, the assassin of the late Envoy and treacherous destroyerof the Cabool force, having collected a body of Troops, flushed with a success consummated by the vilest means had advanced to Murkhail within 7 miles of our gates. He attacked our foraging parties with a large body of Horse on the 21st and 22nd of Feb., and soon after establishing his Head Quarters to the westward 2 miles from the place, and a secondary camp to the eastward about one mile distant, invested the

Digitized by Google

town and established a rigorous blockade. From that time up to the 6th of April, the reduced Garrison was engaged in a succession of skirmishes with the enemy, who, greatly superior in horse, perpetually insulted our walls by attacks and alerts, and compelled us daily to fight at disadvantage for forage for our cattle. The most remarkable of these affairs, were those of the Cavalry under Lieutenant Mayne, commanding detachment Shah Soojah's, 2nd Cavalry, and Jemadar Deena Singh, 5th Light Cavalry, already reported; a sally under Colonel Dennie, C. B, to defeat a suspected attempt of the enemy to drive a mine, on the 11th of March; the repulse of an assault upon the transverse walls to the northward of the place, on the 24th of the same month, by detachments under Captain Broadfoot, (who was severely wounded,) and Captain Fenwick, H. M.'s 13th Light Infantry; the capture of bullocks and sheep by Lieutenat Mayne on the 30th and 31st of January, and the seizure of large flocks of the latter, in the face of Mahomed Akhbar's Army, by a force of Infantry under Captain Pattison, H. M.'s 13th Light Infantry, and of Cavalry under Captain Oldfield, on the 1st instant. These successes were crowned by Providence by the issue of the brilliant and decisive attack on the camp of the Sirdhar, on the 7th instant.

I have to notice as a measure of defence, my having enrolled as a Provisional Battalion a large body of our camp followers, and armed them with pikes and other weapons. On all occasions of assault and sally these men were available to make a show upon our curtains, and I have pledged myself to them to recommend to Government, that they should enjoy all the pecuniary advantages of Native soldiers beyond the Indus. I at the same time held forth to the troops of Shah Soojah's Force, the expectation that they would be put, during the especial service, on the same footing with their comrades of the Bengal Army.

From the time that the Brigade threw itself into Jellalabad the Native Troops have been on half, and the followers on quarter rations, and for many weeks they have been able to obtain little or nothing in the bazaars to eke out this scanty provision. I will not mention as a privation the European Troops from the same period having been without their allowance of spirits, because I verily believe this circumstance and their constant employment have contributed to keep them in the highest health and the most remarkable state of discipline. Crime has been almost unknown amongst

Digitized by Google

them, but they have felt severely, although they never murmured, the diminution of their quantity of animal food, and the total want of ghee, flour, tea, coffee, and sugar; these may seem small matters to those who read of them at a distance, but they are serious reductions in the scale of comfort of the hard working and fighting soldier in Asia. The Troops have also been greatly in arrears of Pay besides their severe duties, in heat and cold, wind and rain, on the guards of the gates and bastions. The Troops, Officers, and men, British and Hindoostanee, of every arm, remained fully accoutred on their alarm posts every night from the 1st March to the 7th of April. The losses of Officers and men in carriage cattle, camp equipage, and baggage, between Cabool and Jellalabad, were heavy, and their expenditure, during the siege and blockade, in obtaining articles of mere subsistence and necessity, has been exorbitant.

I feel assured that Major General Pollock will consider it a most pleasing duty, to bring the series of labours, privations, and conflicts, imperfectly sketched in the foregoing details, to the notice of the head of the Supreme Government in India, and through his Lordship to that of the Court of Directors and of our Sovereign, as a claim for public acknowledgment and substantial reimbursement and reward.

The report of Captain Broadfoot in his capacity of Garrison Engineer will meet with attentive perusal: I have already stated how much I have been indebted to his scientific attainments, as well as his distinguished activity and resolution during the siege. His fertility in resources obviated great difficulties, in procuring iron, timber, and charcoal, and, to the foresight of his arrangements, we owe our having had a very ample supply of tools. The Corps under his command performed, from Bootkhak, the duties equally of good sappers and bold light infantry soldiers, and the Affghan Huzaree and Yusifzye portion of it have been singularly faithful in time of general defection. The two Infantry Regiments under the lamented Colonel Dennie and Lieutenant Colonel Monteath, have vied with each other in the steady performance of the duties of that arm, and it would be impossible for me to discriminate in favor of either, in awarding praise to the squadron 5th Light Cavalry under Captain Oldfield, and the Ressalah 2nd Shah Soojah's Cavalry, under Lieutenant Mayne; Lieutenant Plowden of the former has been distinguished on several occasions. The Artillery practice of No. 6, Light Field Battery, has ever

Digitized by Google

been excellent, and has been equalled by that of the Mountain Train. Captains Abbot and Backhouse, and Lieutenant Dawes, have proved themselves excellent Officers of Ordnance. I have more than once brought it to notice that Captain MacGregor, Political Agent, has cheerfully rendered very able assistance in serving the guns in every crisis of pressing danger. Of his labours in his own department, I ought not perhaps to attempt to constitute myself a judge; but I know that they have been unremitting, and their result, in obtaining for my Force supplies and information, and keeping up our communication with India and with Cabool, and securing for us Affghan co-operation, I may be allowed to appreciate and am bound to point out to Government.

The medical duties of the Garrison have been ably fulfilled by Surgeon Forsyth, Superintending Surgeon Shah Soojah's Force, and Assistant Surgeons Robertson and Barnes, H. M. 13th Light Infantry, Hare, 35th Regiment, and Brown, late in charge of the Irregulars.

Captain Mainwaring, Commissariat Officer to the Force, has been indefatigable in his efforts to keep the Garrison well supplied, and his arrangement in very difficult times have merited my highest praise. Captain Moorhouse, 35th Regiment Native Infantry, has satisfactorily discharged his duties as Brigade Quarter Master; he was severely wounded on the 7th instant.

It is gratifying to me to forward the opinion of my second in command, Lieutenant Colonel Monteath, C. B, placed on record without solicitation, of the merits of the 13th Light Infantry, of which Corps I am proud of being a member: I fully concur in the sentiments which he expresses, and hope the distinction which he recommends for the Officers of his own Corps will be accorded. The cheerful and persevering manner in which the Native Soldiers laboured with the shovel, mattock, and hand-barrow were as surprising, as their steadiness and courage in the field were conspicuous.

I have to acknowledge the zealous manner in which Brevet Major Fraser, Light Cavalry, Brevet Captain Gerrard, of the Corps of Jazailchees, Captain Burn, and Lieutenant Hillersden, of the Khyber Rangers, and Lieutenant Dawson of the Janbazes, when their services could no longer be available with their Corps, volunteered to do duty with any Regiment in which they could be useful.

Digitized by Google

I must finally express my gratitude to Providence for having placed so gallant and devoted a Force under my command; in every way it has exceeded my most sanguine expectations, and I beg leave in the strongest manner to solicit the interposition of Major General Pollock, C. B., who has nobly laboured and fought to relieve it from its critical position in the midst of a hostile empire, in now committing it to the protection and favour of the Right Honorable the Governor General in Council, and through him of the Court of Directors and of our Sovereign.

I ask permission specially to recommend the following Officers for honorary distinctions or Brevet Rank, or both, viz.: Lieut. Col. Monteath, C. B., Commanding the 35th Regiment Native Infantry, now second in Command; Brevet Major Fraser, Light Cavalry, who acted as my Aid de-Camp on the 7th instant; Captain Abbott, Commandant of Artillery and Commissary of Ordnance; Captain Backhouse, Commanding the Mountain Train, and Senior Officer of the Shah's Troops with my Force; Captain Broadfoot, Commanding Sappers and Garrison Engineer; Captain Oldfield, 5th Light Cavalry, Senior Officer of that arm; Captain Seaton, 35th Regiment Native Infantry, particularly recommended for his conduct on the 7th Instant by Lieut. Colonel Monteath; Captain Younghusband of the same regiment, who was distinguished with the advanced guard in the Khoord Cabool Pass and there severely wounded; Captain Burn, late Commandant of the Khyber Rangers and doing duty with the 35th Regiment N. I.; Captain Wilkinson, on whom the Command of the 13th Light Infantry devolved in the field on the fall of Colonel Dennie, C. B.; Captain Fenwick, Her Majesty's 13th Light Infantry, whose highly deserving conduct in the Pass of Jugdulluck was noticed then in my despatch; Captain Havelock, H. M.'s 13th Light Infantry, Persian Interpreter to Major Generals Elphinstone and Pollock, and attached to me as staff, and who commanded the right column in the final attack on Mahomed Akbar's Camp; and Captain Hamlet Wade, H. M.'s 13th Light Infantry, my Brigade Major, whose exertions in the action of the 7th, I have elsewhere highly commended. Both these latter Officers rendered most valuable services throughout the investment and siege. The Officers of all ranks and soldiers of all arms, European and Native, I have likewise to represent as generally and individually deserving of reward and encouragement, and I hope that the Government will sanction my calling upon the Commandants of Corps and

Digitized by Google

Detachments to send in Rolls of such Native Officers as they may deem worthy of the Insignia of the Order of "Merit" and of "British India."

Rank and Names of Officers Killed and Wounded.

Corps.	Officers' Names.	Wounded.	Remarks.
Artillery.....	Capt. Abbot.. ..	Slightly.....	
Sapa. & Miners....	Capt Broadfoot.	Severely.....	
H. M. 13th L. I.....	Lt.&Adt. Wood.	Slightly.....	
"	Ensign Oakes...	Slightly.	

(Signed) R. SALE, Major General.
Commanding the Force.

Examined. (Signed) HAMLET WADE, Capt.
Major of Brigade.

Return of Killed and Wounded, and Missing of Troops under the Command of Major General Sir R. H. Sale, K. C. B. from 22nd Feb. to April 6th 1842.

KILLED.

No. 6, Light Field Battery—1 Corporal.
Detachment 5th L. C.—1 Serjt. and 2 Privates.
H. M. 13th L. I. 4 Privates.
35th Right. N. I.—1 Private.
Detachment and Cavalry, S. S. F.—1 Private.
Sappers and Miners—4 Privates.
Total killed—1 Serjeant, 1 Corporal and 12 Privates.

WOUNDED.

No. 6, Light Field Battery—1 Officer and 1 Private.
Detachment 5th L C.—4 Privates.
H M. 13th L. I.—2 Officers, 1 Corporal, and 11 Privates.
35 Regt. N. I —1 Corporal and 10 Privates.
Detachment 2nd Cavalry, S. S. F.—4 Privates.
Sappers and Miners—1 Officer and 30 Privates.
Total wounded—4 Officers, 2 Corporals and 60 Privates.

HORSES.

Detachment 5th L. C.—1 killed and 12 wounded.
Detachment 2nd Cavalry—9 killed and 3 wounded.
Total Horses killed 10; wounded 15.

(Signed) R. SALE, Major-General,
Commanding the Force.

Examined. (Signed) HAMLET WADE, Capt.
Major of Brigade.

Digitized by Google

Return of Camp Followers enlisted on the 15th of January, 1842, by order of Major General Sir R. Sale, K. C. B. as a Provisional Garrison.

Jellalabad, April 1st, 1842.

	Mustered Followers		Not Mustered Followers		Total.	Killed during the siege.	Wounded during the siege.	Remarks.
	Armed.	Unarmed.	Armed.	Unarmed				
No. 6, Light Field Artillery.	36	0	61	0	97	2	0	The followers that were unarmed were told off to the Ramparts, for the purpose of throwing large stones, a great quantity of which were collected; the whole of the Camp rendered much assistance, in the conveyance of building material, and working with furwahs and spades.
Squadron 5th Light Cavalry.	7	69	6	19	101	0	0	
Resallah Anderson's Horse..	4	11	0	57	72	0	0	
H. M.'s 13th Light Inf.....	124	238	100	0	462	0	0	
35th Regt. Native Inf...	77	46	55	110	238	0	0	
Sappers and Miners.....	69	19	40	61	189	0	0	
Commissariat.....	103	0	0	0	103	7	6	
Total...	420	383	262	247	1312	9	6	
	803		509		1312	9	6	

(Signed) R. SALE, Major General,
Comg. Garrison Jellalabad.

Examined. (Signed) HAMLET WADE,
Major of Brigade.

Digitized by Google

From Lieutenant Colonel J. MONTEATH.

Commanding 35th Regiment.

To Major General Sir R. SALE. K. C. B.,

Commanding in Garrison, Jellalabad.

Dated Jellalabad, 16th April, 1842.

SIR,—The exertions of the Garrison of Jellalabad beyond ordinary routine, having ceased since the decisive victory obtained over the enemy on the 7th instant, and now finally terminated by the arrival of the British Army under Major General Pollock, C. B., I trust I may not be considered as going beyond the limits of my proper duty in addressing you, to state as follows.

As doing but due justice on this occasion to Her Majesty's 13th Light Infantry might be looked upon as a highly colored record of the merits of your own Regiment, and seeing that no such partial bias can possibly be supposed to guide my feelings in the estimate I have formed of their deserts, I have pleasure in sincerely declaring, that their conduct, throughout the painful and perilous position in which they have so long been placed, has been such has fully to deserve the applause and admiration of their country and the confidence and the best consideration of our well beloved Sovereign.

On our throwing ourselves on the 12th of November last, into the old and mined town of Jellalabad, without money, without food, and almost without protection, with a nation of highly excited and barbarous enemies in arms against us, our situation seemed as hopeless a one as British Troops were ever called upon to confront ; notwithstanding which the enemy was twice within twenty days attacked, and on both occasions defeated with signal success.

You yourself will doubtless detail the work performed by the Regiment, let it then be only my province, who have witnessed their exertions almost hourly during a period of five months, to record that their devoted perseverance and cheerfulness amidst all the gloom that surrounded them after the destruction of their comrades of the Cabool Force, could not have been surpassed by any troops in the world : and that after months of extreme toil, when an earthquake, such as man is not often in the habit of experiencing, in a moment left scarcely a vestige of their labour standing, their flying as they did with redoubled zeal to the work and completing it in ten days, (so that on the arrival of the enemy before Jel-

H. CHAMIER, *Chief Secretary.*

Digitized by Google

In regard to the Native Troops of all arms, I shall refrain from saying much for a reason which has in a measure induced me to address this letter to you, but as you have yourself been a daily witness of their conduct under every description of circumstance, you have it fully within your own power to say all, of which the Government they serve may very justly feel proud, and it may serve to shew as an example for imitation, what noble enthusiasm and zeal may be lighted up in their breasts, by the high bearing and considerate conduct of determined British Officers.

I shall conclude by observing that we can now, Sir, proudly march forth from this Garrison with the enemy's standards in our hands, and their captured cannon to fire a salute, on delivering over the care of the honor of the British name, which we have had within our keeping for the last 5 months, pure and unspotted, and without a single circumstance existing to cast a breath upon its lustre.

The conduct of the Officers of the 35th Regiment generally, as well as those doing duty with it throughout the siege, I am proud to say, has been such as well to deserve any reward or distinction that can be conferred upon them.

Of those holding the rank of Captain and above it, which enables Her Majesty to advance them a step, I could strongly recommend Captain Seaton, 35th Regt.; Captain Youngehusband, 35th Regt., (severely wounded;) Brevet Major Fraser, late 2nd Light Cavalry, and Captain Barn, 1st Regt, Native Infantry, both doing duty with the 35th Regiment.

Of the Native Officers of the 35th Regiment, I could also strongly recommend; that six should, as a compliment to the Regiment for its gallant and meritorious conduct, receive the Order of "*Merit*" and of "*British India*;"—viz.

Sahib Ram, Subadar,
Manick Sing, Subadar,
Derrion Sing, Jemadar,
Rambuccus Tewarry, Jemadar,
Hoolass Ram, Subadar, and
Hurram Sing, Jemadar.

I have the honor to be, &c.
(Signed) J. MONTEATH, Lieut. Colonel,
Comdg. 35th Regiment.

(True Copy).
(Signed) R. C. SHAKESPEAR, *Mily. Secy.*
By order of the Governor General.
T. H. MADDOCK,
Secy. to the Govt. of India,
with the Govr. Genl.

Re published by order of the Right Honorable the Governor in Council.

Digitized by Google

MEMORANDA CONNECTED WITH THE MANUFACTURE OF GUNPOWDER AT THE MADRAS POWDER MILLS; BY CAPT. G. ALCOCK, *June*, 1842.

Gunpowder is an explosive propellent compound, consisting of Saltpetre, Sulphur, and Charcoal.

Saltpetre.—The principal ingredient in the manufacture of Gunpowder is Saltpetre, and that used in India, is the produce of the country; it is found to abound in nitrous earths, and is refined to about 80 per cent purity, before it is received at the Manufactory, where it undergoes the following processes.

In its crude state, as received from the contractor, it is washed four times with mother or saturated water, and this washing is considered equivalent to one boiling—it is washed,

1st	with	30	Gallons of	water to a Candy
2d	„	20	„	„
3d	„	20	„	„
4th	„	20	„	„

After the washing, the Saltpetre is removed into baskets, and well drained, previous to boiling; it is allowed to remain in the baskets, placed over receiving tubs, for about 24 hours, the water so recovered in the tubs, is retained and mixed with other mother waters.

The Saltpetre is then put into a boiler with 30 per cent. of common water, and boiled for 3 hours—while boiling, it is well skimmed—after which the fire is removed, and the solution allowed to settle for about an hour.

After settling, the liquid is run from the boiler into a large wooden vat, and thence by a trough into the crystallizing pans; in the bottom of the vat, there is a small quantity of straw covered with sand, and over which a piece of cotton cloth is placed; this acts partially, as a filter to the solution running through the vat into the crystallizing pans.

Digitized by Google

The crystallizing pans are made of copper 48 inches in diameter, and 16 inches deep, the solution remains in them about 36 hours, in which time the crystals are formed; the liquid remaining in the pans with the crystals is termed a mother water, and is removed, after which the crystals are broken up, and well washed in another mother water; which has been previously recovered from a 3d boiling, the Saltpetre is then basketed as before after the washing, and this is called the 2d boiling.

When well drained, the Saltpetre is again taken from the baskets and put into another boiler for the 3d boiling—it is boiled about 3 hours with 50 per cent of common water, then drawn off into another set of pans, and allowed to settle and crystallize for 48 hours, the liquid or mother water of this boiling is taken out of the pans, and the crystals well broken up, and basketed; these operations are performed in the same manner as described after the 2d boiling, besides which,3 gallons per candy of distilled water are sprinkled over the Saltpetre in the baskets from a garden watering pot, to remove any impurities that may still remain even after the 3d boiling.

Pulverizing Room.—From the baskets, after the 3d boiling the nitre is carried into the Pulverizing room, where seventy pounds are put into a copper pan and well dried over a slow fire, when dried 23 pints of distilled water, sufficient to dissolve the nitre, are added to it, and the solution is boiled very slowly and kept well stirred with wooden spatulas, till the water is entirely evaporated and the nitre pulverized.

The nitre in a pulverized state is removed from the pans to the weighing room, and from thence in due proportions to the mixing room. The waters of the 2d and 3d boiling after washing the raw Saltpetre are thrown together and evaporated in a large iron boiler for 2 days, the proceeds after crystallization are boiled over again and this is what is called the first boiling, and when a sufficient quantity is so recovered, it is mixed with an equal quantity of raw Saltpetre and boiled as before directed for the second boiling. The waters arising from the evaporation of the 2d and 3d waters is that from which the *sale* Saltpetre is recovered and the process of evaporation is repeated until all the nitre it contains is recovered.

Sulphur.—The Sulphur is imported, it is prepared and its impurities are removed by fusing.

Digitized by Google

Two thousand pounds of Sulphur are put into an iron boiler over a slow fire, and so melted or fused; while in a state of fusion it is well skimmed, and allowed to settle for about an hour, after which it is removed by iron hand ladles into tubs, where it cools and hardens, after 48 hours it is turned out of the tubs, in one solid mass from each tub. the impurities have been precipitated to the bottoms and the sides of these masses, and those portions are removed by hand mallets, and scrapers, and set aside for another fusion (when a sufficient quantity is so collected) the remainder being pure Sulphur is removed into the Pulverizing room, and broken up into convenient lumps for pounding by the hand, with wooden beaters, there are several round holes cased with copper, in the wooden floor of the room, to receive the beaters in pounding the sulphur.

After being tolerably well pulverized, by the hand the sulphur is put into a bolting mill in the same room, the mill is turned by the hand, and the bolter of it, is covered either with fine silk or Arnee muslin. On turning the machine, the Sulphur which passes through the silk into a receiving box placed under the bolter, is considered in a fit state for mixing with the other ingredients for Gunpowder and is conveyed into the weighing room—the remainder, which is not sufficiently pulverized passes out at the open end of the bolter into another box, and is beat up again by hand—and returned into the bolting machine for further pulverization.

Charcoal.—The Charcoal is prepared for the Manufactory from the Dhal plant or Grambush, it ought not to exhibit any salt on being treated with boiling distilled water, and tested, and if thoroughly burnt, it ought not to give out any smoke when heated; previous to pulverization the Charcoal is dried and sifted in the godown yard, and from thence conveyed to the Charcoal pulverizing room.

The Pulverizing machine consists of two metal rollers about 3 feet in length and 9 inches in diameter, placed horizontally across a bolting mill, and parallel to each other, there is a feeder over the roller through which the Charcoal to be pulverized falls gradually between them; The Rollers are turned by a handle fixed to one of them, and in turning they grind the Charcoal which runs from between them into the bolting mill, the bolter is covered

Digitized by Google

with fine wove brass wire, and acting as a sieve the revolution of the bolter throws the finer pulverized Charcoal into a receiving box—the coarser Charcoal passes out at the end of the bolter in the same manner as has been before described with the Sulphur—and is put back again into the machine for further pulverization.

There is a second bolting machine, the bolter of which is covered with a finer description of wove brass wire, through which the fine Charcoal is again sifted before it is considered sufficiently pulverized to be carried into the weighing room.

Having described the different processes necessary for preparing and refining the ingredients for mixing and manufacturing Gunpowder, the following are the proportions of each used to one hundred pound weight, viz.

Nitre.	Sulphur.	Charcoal.
lbs.	lbs.	lbs.
75	$11\frac{1}{3}$	$13\frac{1}{3}$

When one mill only is at work fifteen mixing boxes are used in the mixing room, each box contains the following proportions for one mixing, vizt.

Nitre.		Sulphur.		Charcoal.	
lbs.	oz.	lbs.	oz.	lbs.	oz.
22	10	3	8	4	2

Mixing Room.—In the mixing room the nitre according to the foregoing proportion is put into the mixing box, and undergoes a further pulverization by a hand roller made of lignum vitæ, which is worked backwards and forwards for one hour and a half, the proportion of Sulphur is then added to the nitre, and rolled as before for about half an hour, when the Charcoal is mixed with the nitre and Sulphur, the

Digitized by Google

three ingredients are now well worked together for two hours more, the whole process occupying about four hours.

One man mixes the above quantity twice in one day, viz. 60½ lbs. and that is called one mill charge—the wastage on the two operations is about eight ounces to each box, reducing a charge to 60lbs—the quantity therefore mixed in one day in the fifteen boxes is 900lbs. and this when mixed is conveyed in small tubs to the mill for further incorporation.

The Mills.—One mill consists of two upright cylinder wheels 5 feet in diameter and 18 inches broad—they are made of gun metal and are placed opposite to each other in a circular basin (also made of gun metal) which is called the bed, in which they revolve.

The cylinders weighing 6 tons each, are connected by a metal axle 10 feet in length, this axle passes through a vertical shaft of wood which turns in two sockets, the lower socket is fixed in the centre of the bed, and the upper one in a large beam across the mill room, two draft poles are fixed in the vertical shaft, to each of which a pair of bullocks is yoked to turn it.

The revolution of the vertical shaft turns the cylinder wheels over the composition in the bed, the composition is kept under the cylinders by four ploughs, fixed to arms passing through the vertical shaft; the distance between the cylinder wheels is four feet.

The composition having been brought from the mixing room, one charge or 60lbs. is placed on the bed of the mill and sprinkled with 4 pints of distilled water; the mill is then put in motion, and at the seventieth revolution, 20 pounds of gunpowder dust received from the corning room is added to the above quantity of composition, without stopping the mill, which continues revolving till it has completed one hundred revolutions, which number is denoted by a tell-tale or dial plate; the time occupied with one charge is 35 minutes.

The nature of the dust which is added to the composition will be explained hereafter.

The composition is pressed into hard cakes by the weight of the cylinders, in which state it is removed into the drying yard, there are four mills in the manufactory but only one

Digitized by Google

mill usually at work, it incorporates in one day about 1500lbs. of composition, viz.

	Charges.	lbs. each.	Total lbs.
Composition received from the mixing room.....	15	60	900
Dust added to the above from the corning room.....	15	20	300
Dust incorporated by itself.....	4	80	320

Drying Yard.—The composition in cakes having been brought over from the mills to the drying yard, is spread out on powder cloths, and broken up by hand mallets, it is allowed to remain exposed to the sun until it is well dried—when the broken cakes are carried into the corning room, this process takes from an hour to two hours according to the state of the weather.

Corning Room.—The various brass wire sieves for sifting the composition are kept in the corning room—there are six different sizes, viz.

Sieves with 10 holes to the inch.
„ „ 14 „ „ „
„ „ 18 „ „ „
„ „ 24 „ „ „
„ „ 30 „ „ „
„ „ 36 „ „ „

The wooden floor of the corning room is covered with lead, and the composition as it is brought over from the drying yard after being mixed together, is in the first instance, put into No. 10 sieve, the dust and smaller grains passing through it, are put on one side of the room, the remainder, is turned out, and spread on the leaden floor, and beat up until the whole passes through No. 10 sieve, the dust is now separated from the composition by sifting the whole in No. 36 sieve, and then it is resifted according to the sized grain that is required, either for C. P. or cannon powder, or M. P. or musket powder, the only two descriptions of powder, now manufactured at Madras.

Digitized by Google

The grains for the C. P. are passed through No. 10, 14 and 18 sieve, and the M. P. is passed through No. 24 and 30 sieves.

The dust arising from these various processes of beating up, sifting and resifting is set aside to be mixed with further portions of dust brought from the winnowing room, and it is thence carried to the mill—either in charges of 20lbs. each to be added at the 70th revolution of the mill, or to be worked up by itself in charges of 80 lbs. as before related.

When the composition has been reduced into grains of gunpowder of the size required, it is conveyed in transporting barrels, containing about 60 lbs. each to the drying terrace room.

Drying Terrace.—The drying terrace consists of four wooden platforms 21 feet square, covered with sheet copper and surrounded by a wall 15 feet high.

The gunpowder from the corning room is spread on powder cloths laid over the terrace as early in the morning as the weather will admit, to allow the heat to penetrate gradually through the grains, the powder is occasionally stirred with a wooden rake and remains exposed for about three hours, varying in time according to the heat of the sun, or until the thermometer rises *above* 136° Farht. after this first day's drying the powder is carried over in the transporting barrels to the winnowing room, where it is sifted in No. 36 sieve, to separate any further dust from the grain arising from the drying process, the dust is set aside for incorporation in the mill as before described, and the powder is conveyed back to the drying terrace for a second day's exposure to the sun—which is generally considered sufficient; it is then taken over to the winnowing room again, and after being winnowed for the purpose of effectually removing any remaining dust—it is carried to the barrelling room, where it is weighed and put into either 90 or 45lb barrels.

Winnowing Room.

Barrelling Room.

The gunpowder is now fit for use and a specimen of each kind viz. of C. P. and of M. P. is selected once a month and forwarded to Artillery Head Quarters for proof. The powder is also proved daily at the manufactory, for the satisfaction of the Superintendent.

Digitized by Google

SINGULAR MANNER OF CROSSING A RIVER.

The mode in which we passed the rivers was singular, and, I believe, quite peculiar to this part of the country. We were drawn by a pair of horses who were yoked to the boat on each bow by a rope fixed to the hair of the mane. The bridle is then put on as if the horse were to be mounted; the boat is pushed into the stream, and, without any other assistance than the horses, is ferried directly across the most rapid channel. A man on board holds the reins of each horse, and allows them to play loosely in the mouth, urging him to swim; and thus guided, he advances without difficulty. There is not an oar to aid in impelling the boat; and the only assistance from those on board consists in manœuvering a rude rounded pole at the stern, to prevent the vessel from wheeling in the current, and to give both horses clear water to swim. They sometimes use four horses; and in that case, two are fixed at the stern. These horses require no preparatory training, since they indiscriminately yoke all that cross the river. One of the boats was dragged over by the aid of two of our jaded ponies; and the vessel which attempted to follow us without them, was carried so far down the stream as to detain us a whole day on the banks, till it could be brought up to the camp of our caravan. By this ingenious mode we crossed a river nearly half a mile wide, and running at the rate of three miles and a half an hour, in fifteen minutes of actual sailing; but there was some detention from having to thread our way among the sand-banks that separated the branches.

Digitized by Google

MOULMEIN TIMBER.

Remarks by Captain Simpson, Commanding Artillery, Moulmein; and Captain Babington, Deputy Assistant Commissary General; on the different descriptions of Timber procurable in the Tenasserim Provinces.

Captain SIMPSON, *Artillery.*

Captain BABINGTON, *Depy. Assist. Comy. Genl.*

No. 1 ANAN.

A close grained wood, very hard and heavy, with great tenacity of fibre, sinks in water even when well seasoned, is impervious to white ants, is plentiful and grows to a great size, being readily procurable of dimensions varying from four feet to three in diameter.

It is used chiefly in the Provinces for wall plates and beams of houses, it is also used for making planes, and handles for tools.

This wood, as far as I can learn, is held in almost equal estimation with teak here—having to a great extent the same properties, and being used almost indiscriminately with it, by *Burmans*. There is not much in this District. It abounds on the Yê, and Amherst Districts. Stem from 45 to 47½ feet in length, from 4½ to 9 feet round—often much larger, tapers but little, great durability is one of its qualities, not attacked by ants. I would recommend this wood.

No. 2 BAMBROOL

A close grained, heavy, hard wood, not so plentiful as the Anan, but said to be even more durable; this wood however is generally very knotty, and rather stunted in growth—may be procured of dimensions from one to two feet in diameter.

It is used chiefly for bridge posts, and with advantage for all purposes when there is exposure to the weather.

Not much esteemed, subject to quick decay, and soon insect eaten, either in or out of water, and above or below ground. Of large dimensions and plentiful—I do not recommend it.

Digitized by Google

Captain SIMPSON, *Artillery.*

Captain BABINGTON, *Depy. Assist. Comy. Genl.*

No. 3 KATZEE.

A wood of particularly fine close grain, very strong and durable, plentiful, in growth but rarely exceeds one foot in diameter in dimensions.

It has been found to answer well for making cogs for machinery, and is lighter than most of the other close grained woods of these Provinces.

Properly "Theetsee" I am told; exuding a red gum which repels ants, a very red wood, not plentiful, takes a high polish, grows large, is durable, grows large in the *North*, good for furniture—and I would recommend the large for general purposes.

No. 4 PEENGADAN KULAY

OR

SMALL PEENGADAN.

A fine close grained, heavy and handsome wood. Is held in great estimation by the Burmans for making planes, and frames of tools, where even surface and durability are required.

There are two species of Peengadan (vide No. 9) the distinction in name arises from the No. 4 Peengadan having a smaller leaf, the woods are very similar, both are plentiful, and may be procured in size equal to the largest of the hard woods of the Provinces.

This is both No. 4 and No. 9, of Capt. Simpson's Memo. the only difference being that one is larger and the other smaller (Khūllay) this wood (the larger only) I would recommend for *large buildings* chiefly. It is very durable, found in plenty all over these Provinces, the larger the further you go North, very close grained and heavy, will not float, tapers little, 30 to 35 feet stem, 4½ to 7½ feet round (the large).

Digitized by Google

Captain SIMPSON. *Artillery.*

Captain BABINGTON. *Depy. Assist. Comy. Genl.*

No. 5 THICKYA
OR
ITCHING WOOD.

Grain not very close, but a tough wood, and said to be very durable.

This is the most abundant of the jungle trees in the vicinity of Amherst, prefering high localities. many of the hills being covered with this tree alone, and of superb dimensions, some of them exhibiting a straight trunk of from sixty to eighty feet to the lowest branches. It is a wood easily worked up, and used much for common purposes, but owing to the Burmans not allowing due time for seasoning it is liable to split. It shews when broken a long good fibre.

This tree derives its name from the peculiar properties of its Bark, which is composed on the exterior surface of particles of the finest texture, very similar to the bristly down of the cane leaf, and on being touched by the hand, leaves a number of these fine particles in the skin causing considerable irritation.

Not at all recommended for any purpose, rots speedily, of small dimensions. Plenty of it.

No. 6 THEENGAN.

A well grained, good wood, durable and tough, may be

This is one of the very best woods of these Provinces I

Digitized by Google

Captain Simpson.	Captain Babington.
Artillery.	*Depy. Assist. Comy. Genl.*
termed the oak of these provinces, is procurable of good dimensions, and is applied to almost every purpose with advantage.	believe—but it is scarce, grows near streams and rivers—will not float, requires 3 years to season, *very* durable. Does not splinter, grows to the largest dimensions, canoes are cut out of it. Little has been cut here, and most of what is standing is of very large dimensions. It can be had to square 24 inches, and has stems 50 to 70 feet high, tapering little to first branch. I would recommend this wood.

No. 7 THENGIN.

Aspecies of the above but of closer grain, harder and heavier, indeed is one of the hardest woods of the provinces, and grows to a great size, on elevated sites it is plentiful. One of these trees in the vicinity of Amherst was felled a short time since, and measured nineteen and a half feet in circumference, straight and even to the lower branches, which commenced about sixty feet from the ground. It is used by the Burmans for making canoes, a boat of the largest size beingformed from the trunk of one tree. Both the above species, Theengan and Thengin produce freely a gum resin, but the Thengin in greater abundance a sample of this resin I forward with the woods.

This wood is a species of Theengan (No. 6) exactly the same as it, in all respects, but color. From what I can learn the two woods are to be recommended for the same purposes and are about equal in quantity procurable.

Digitized by Google

Captain Simpson.	Captain Babington.
Artillery.	*Depy. Assist. Comy· Genl.*

No. 8 THARAPEE.

A well grained, very tough wood and durable ; plentiful on high sites, is much used for Masts for large boats, it possesses great elasticity. It is a tall and graceful tree, and can be procured of dimensions, from 18 inches to 2 feet.

A very inferior wood. Rots under exposure—grows on hilly and mountainous districts—rather large dimensions.

No. 9 LARGE PEENGADAN.

A heavy, very hard wood, of great density, is used chiefly for bridge posts, does not suffer in water or when exposed to weather, appears to possess an essential oil of peculiar properties.

The tree is plentiful in the provinces and may be procured of about three feet diameter.

Vide No. 4.

No. 10 KYAN NAN.

A wood of fair grain, and handsome appearance, is used chiefly by the Burmans for furniture, and purposes of turniug and carving—grows to a fair size, but the tree is rarely found in a perfect state, being liable to large cavities and other imperfections in the centre.

I cannot learn anything beyond what Captain Simpson has said of this wood. But from what I hear of it, I do not at all recommended it.

No. 11 MYA YA MONG.

An even surfaced, well grained wood and tough, grows to a moderate size, and is found chiefly on high sites.

I cannot learn any thing beyond what Captain Simpson has said of this wood. But from what I hear of it,

Digitized by Google

Captain Simpson, *Artillery.*	Captain Babington. *Depy. Assist. Comy. Genl.*
The Burmans use it for making yokes for the shoulder to enable them to carry heavy weights. It is an extremely tough wood with much elasticity.	I do not at all recommend it.

No. 12 KAY YA.

A heavy, very close grained wood can be procured about two feet in diameter. The burmans use it for making *gun stocks* (for which it appears well adapted) and for handles to all descriptions of weapons.

It is a tall graceful tree and readily procurable.

N. B. There are two other valuable woods (Peema) specimens of which, with such information as I can collect shall be forwarded.

(Sd.) G. W. Y. Simpson, Capt.
Comg. Arty T. P.

Moulmein,
7th October, 1841.

N. B. The following not in Captain Simpson's list, but furnished by Captain Babington from a record in the Moulmein Commissariat Office.

No. 13 EENDYKE
OR
BLACKWOOD.

A very strong close grained wood. Has a case of white sap on it, 3 or 4 inches thick, like ebony which it otherwise resembles, very durable, will not float—not plentiful. Heart generally has cracks and flaws, wherefore large planks, &c. cannot be got easily from it. I do not recommend it, from this distance.

Digitized by Google

Captain BABINGTON.

Depy. Assist. Comy. Genl.

No. 14 BASTARD ROSEWOOD.

OR

PADDOWK.

I consider this the next best wood to teak here, from what I am told of it, of great tenacity and durability. Is not attacked by white ants, I am told; has a remarkable strong and not disagreeable odour. It is heavy; otherwise I should suppose it to be the best wood for gun carriages, owing to its great toughness—sound heart—large dimensions, but not so large as teak—plentiful up the Hondroo river, and in Shan Karreenee and Pegu.

No. 15 PEE MĀ.

There are several species of this wood both red and white, pretty similar in properties and dimensions. Used a good deal at Rangoon and Chittagong for Ship building. If *thoroughly seasoned* it is durable *under water*, not otherwise. Has a grain like beech, and works up like elm I am told, but from its not being durable I would not recommend it much from this distance.

MEMORANDUM.

I am informed probably about 3000 tress per annum, might be hereafter obtained from these forests, of the

Digitized by Google

kinds and sizes I would recommend for experimental adoption, on such a scale as to give the wood a fair trial in all respects ; viz. Anan, Paddowk, Peengadow, (large) Theengan, Thengin and Theetzee. All but Anan are difficult of transport however, owing to their weight, and not floating well, so that they would require conversion I fear in the forest; but experiment might supersede this difficulty. As to expense, none whatever would attach to the abstraction of the wood, beyond perhaps Government Kist, at 15 per cent *ad valorem*, that is upon such value as the Commissioner might fix upon it, for, as I have elsewhere said, these woods are practically unknown as yet in this market. The only other expense would be the employment of Government Elephants, and people to fell, convert, transport, &c. the wood, but these are costs attaching to all wood: *no prime cost*, I believe would attach to those in question.

(Signed) D. Babington,

Depy. Assist. Comy. Genl.

Commissariat Office, T. P.
Moulmein, 25th May 1842.

REORGANIZATION OF THE NIZAM'S ARTILLERY.

General Orders by the Resident, on the part of the Nizam's Government, Hyderabad Residency, 30th June 1842—*No.* 140.

On a revision of the Establishment in the Artillery and Ordnance Departments of the Nizam's "*contingent*," the Resident is pleased to direct that the following arrangements shall take place from the 1st August next.

Four field guns, with ammunition tumbrils complete, are to be considered the established proportion of field ordnance attached to the companies of Artillery at Bolarum, Aurungabad, Ellichpoor, and Hingolee. These batteries are to be maintained in a state of the most perfect efficiency, ready to take the field at the shortest notice.

Digitized by Google

ESTABLISHMENTS.

	Companies.				At Lingsoogoor
	1st	2nd	3rd	4th	
Ordnance.					
Guns iron 18 Pounder	2	3	0	2	0
„ „ 12 „ ..	0	0	0	0	2
„ „ 6 „ ..	4	4	4	4	0
Brass Mortar 8 inch ..	0	2	0	0	1
„ „ 5½ „ ..	1	0	0	0	1
„ Howitzer 12 Pounder	1	0	0	1	0
„ „ 8 inch ..	0	2	0	0	0
„ „ 5½ „ ..	2	0	0	2	0
Europeans.					
Capt. Commandant or Captain	1	1	1	1	0
Lieutenant	0	0	0	0	1
Quarter Master	1	1	1	1	0
Quarter Master Serjeant	0	1	0	1	1
Golundauze Company.					
Subadar Major	1	1	1	1	0
Jemadars	2	2	1	2	1
Havildars	5	5	4	5	2
Naigues	5	5	4	5	2
Buglers	1	1	1	1	1
Lance Naicks	Included in Privates.				
Privates	80	80	41	80	34
Recruit Boys	4	4	1	0	0
Puckallies	1	1	1	1	0
Gun Lascars.					
Havildars		1	0	1	0
Naicks	1	1	1	1	1
Gun Lascars	24	24	14	20	8
Ordnance Drivers.					
Havildars	1	1	4	1	0
Naicks	1	2	1	2	2
Buglers	1	1	1	1	0
Drivers	56	52	43	51	34
Mootsuddy	1	0	0	0	0
Puckallies	1	1	1	1	0
Bullocks.					
Draft	104	96	80	94	63
Carriage	112	100	70	100	130
Attached.					
Persian Writer	With the S. Department.				
1st Dresser	0	0	0	1	0
Native do.	1	1	1	1	0
Dhobee	1	1	1	1	1
Barber	1	1	1	1	1
Bearers	5	5	5	5	0
Bheasties	0	0	0	0	2
Sweepers	1	1	1	1	0
Native School Master	0	1	1	1	0

Digitized by Google

STORE DEPARTMENT.

	General Depot at Bolarum.	Aurungabad Depôt.	Hingolee Depôt.	Ellichpoor Depôt.	At Lingsoogoor.
STORE DEPARTMENTS.					
Deputy Assistant Commissary.	1	1	0	1	0
Conductor	1	1	1	1	0
Sub Conductor	0	0	0	0	0
Store Serjeants*	2	*2	1	1	1
Serjeants	1	0	0	0	1
Syrang	1	1	0	1	0
1st Tindal	1	1	1	1	1
2nd Tindal	2	1	1	1	0
Puckallies.	1	1	0	1	0
Boys	2	0	0	0	0
Lascars	50	32	16	25	10
ARTIFICERS.					
Maistry Carpenter	1	1	1	1	0
„ Smith	1	1	1	1	0
Wheel wright	1	1	0	1	0
Carpenters	5	6	2	3	1
Turners	1	0	1	0	0
Sawyers	4	3	3	3	0
Coopers	1	0	1	1	0
Painters	1	1	1	1	0
Armourers	0	1	0	0	0
Blacksmiths	4	0	2	2	1
Hammermen	4	4	2	3	1
Bellows Men	4	3	2	2	1
Brass Smith	2	1	1	1	0
Filemen	4	3	1	2	1
Sikilghur	2	1	1	1	0
Moochee	1	1	1	1	0
Chuckler	2	0	0	1	1
ATTACHED.					
Barrack Serjeant	0	1	0	0	0
Draftsman	1	0	0	0	0
Persian Writer	1	1	1	1	0

* One of the Store Serjeants at Aurungabad to be discontinued on the occurrence of the first casualty there.

Digitized by Google

In the above proportion of cattle, there are included for Depôt and executive purposes, at

Bolarum	20	Bullocks
Aurungabad	16	„
Ellichpoor	10	„
Hingolee	10	„

This number being considered amply sufficient for those Departments, the Gun Cattle are to be confined strictly to their own duties, and never employed in carts or other drudgery, nor in any way unconnected with Ordnance purposes.

Carriage Bullocks.—The Establishment of Carriage Bullocks attached to the Aurungabad and Ellichpoor Divisions to be abolished, and the Cattle disposed of under instructions which will be hereafter transmitted.

One hundred contract Bullocks at 3½ Rupees each per month, are authorized for each of the above divisions in lieu of the Establishments hitherto maintained.

The monthly contract for Carriage Bullocks at Hingolee is reduced from 4 Rupees to 3½ Rupees per Bullock, to have effect from the 1st of August next.

DUNDAS'S AND MONK'S GUNS.

The late experiments at Woolwich and the forthcoming ones at Deal, for the purpose of testing the superiority of the new guns, excite just now considerable interest throughout the profession. No greater proof of this can be afforded than the numerous enquiries we have received, not only from officers who have recently served, but those who have been on half pay a considerable time and are probably no longer fit for active service.

Some of these latter, who have not possessed the opportunities now available for acquiring proficiency in Naval Gunnery, express their surprise at the great weight of the 68 pounders on board the *Geyser*, and are anxious to know what benefit is expected to compensate for this inconvenience. The reason is evident: the intention being to produce a great range it cannot be accomplished without large charges of powder, hence the necessity for casting the gun much heavier than was the former practice. The old 68 pounder carronade ("or smasher" as it was originally called)

Digitized by Google

weighed only about 36 cwt. the full charge was 5 lb. 12 oz. and the range (greatest) about 1300 yards, but Colonel Dundas's modern gun of that calibre owing to its weight and form, is capable of bearing a charge of 20lb. of powder and to range a shot upwards of 4000 yards, being considerably more than any piece of Artillery that we hitherto possessed: while Mr. Monk's gun of 97 cwt. throwing a shot of 56 lb., is little, if any, inferior in this repect to the former, which weighs 113 cwt. The principal advantage of the Dundas gun is, its being adapted to an existing calibre; whereas Mr. Monk's shot of 56 lbs. is a deviation from any calibre we already possess.

For steam vessels, guns possessing the longest range are the most desirable, because not only are they calculated to batter a town from a distance beyond the reach of ordinary cannon, but also the shot has greater velocity, and consequently the power of penetrating deeper at low elevations, and thus producing more certain and destructive effect than when it is necessary to elevate greatly in order to reach the object.

This explanation will be sufficient to meet the inquiries addressed to us on this head, and will satisfy those who take an interest in the matter, that the Government is quite awake to improvements and further perfection in our Naval armament, so as to render our steam and other vessels equal, if not superior, to any they may encounter in case of war. It is pleasing to reflect, that, thanks to the excellent establishment at Portsmouth, the palpable deficiency we so long laboured under in respect to sea gunnery has been totally remedied; the bombardment of Acre and the operation in the China seas, affording practical demonstration of what our Tars are capable of, even were not the improvements we have adverted to, continually progressing under the sanction and authority of Government.

NOTES ON THE DEFENCE OF JELLALABAD, PREPARED BY CAPTAIN GEORGE BROADFOOT 31TH M. N. I. GARRISON ENGINEER. 16TH APRIL, 1842.

On the 12th of November the Major General Commanding having resolved to occupy Jellalabad, directed me with a Committee of Officers to examine and report on the works of the place.

The Committee reported unanimously that they were then not defensible against a vigorous assault.

Digitized by Google

As will be seen by the accompanying plan* the town is an irregular quadrilateral, having half of the western side salient, and the southern side broken by a deep re-entering angle. It was surrounded on every side with gardens and houses, enclosed fields, mosques, and ruined forts, affording strong cover to an enemy; these were every where close to the walls and in many places connected with them. Beyond these on three sides, (N, E, and W,) at from 400 to 500 yards run the ruins of the wall of the ancient city, on which the sand has accumulated so as to form a line of low heights giving cover to the largest bodies of men Opposite the south west angle a range of heights, composed of bare gneiss rocks, commences at 330 yards from the works, and extends about 400 yards from N. N. E. to S. S. W; these completely overlook the town, and, from the vicious tracing of the works, enfilade some of the longest curtains. Parallel to the north side at 170 yards runs a steep bank 20 feet high; it extends a considerable way to the west, and several miles to the east, affording a secure and unseen approach to any number of men; it is probably an old bank of the river. From it numerous ravines run up towards the walls affording the enemy a covered passage into the buildings and enclosures adjoining the works.

Two very solid walls, 300 yards apart, run from the place to this bank thus enclosing on three sides a space, probably occupied originally by the Mogul Emperor's palace, but found by us to contain a large mosque, and numerous gardens and houses occupied by fakeers; one of the gates of the town opens into it, and it was traversed by a water course about 10 feet wide, which entered the town by a tunnel under the rampart, large enough to admit several men abreast; a similar tunnel allowed it to pass out of the town on the eastern side.

The walls of the town extended about 2,100 yards without reckoning the bastions, of which there were 33. The works were of earth and in the usual style of the country, viz. a high thin rampart, but in a state of ruin, without parapets and without ditch, covered way, or outworks of any kind.

The bastions were full, but in some places lower than the adjoining curtains, very confined, without parapets, and sloping downwards from the gorge to the salient, so that the terreplein was completely exposed.

* Not received.

Digitized by Google

There were four gates and a postern, all of the usual vicious native construction, and except that on the northern side, in a ruinous state.

To give some idea of the state of the works, I may mention that, of the Committee sent to inspect them on the 13th November, not one except myself succeeded in making the circuit: larpe gaps cut off the communication, or insecure footing compelled the Officers to descend among the adjoining enclosures, from which it was difficult to find the way; while, on the south side, the rampart was so imbedded in houses and surmounted by them, that its course could only be traced by laboriously threading the lanes of the native town.

On the north side the wall rose to a very great height *towards the town*, but sloped down to the exterior in a heap of ruins almost every where accessible, while at the foot were houes and gardens, so strongly occupied by the enemy, that during the night of the 13th of November, our troops were unable to maintain their posts, and with the exception of the gateway, a line of 400 yards on the northern face was without a man on the works, had the enemy then attacked us, we must have been reduced to a street combat.

On the following morning (14th November,) the Major General ordered a sortie in force, which drove the enemy from his positions with such loss, that it was sometime before he ventured near enough to disturb our works, which were now as vigorously prosecuted as our scanty supply of tools and the difficulty of procuring material allowed. We had only the tools, (as per margin,) brought from Cabool with the Sappers, for the operations expected in the Tezeen Valley, and we were without wood or iron. Wood was obtained from the ruins of the cantonment, and from houses demolished in the town. Iron was collected in small quantities from the neighbourhood, but it was that of the country, good in quality but imperfectly smelted, and requiring about ten times as much labour and time as English iron. By the persevering labour of the troops, however, much was done, and when the enemy next attacked us, (1st December,) ramps had been made and the guns mounted on the bastions for which they were destined. The water-courses and other passages through the walls blocked up, the foot of

330 Pickaxes.
390 Shovels.
With other tools in proportion; many tools such as trowels, &c, have been made here.

Digitized by Google

the scarps cleared from rubbish, and parapets built in all the bastions and many of the curtains, while much of the external cover was destroyed.

On the 1st December the enemy were again routed and the works proceeded with little or no interruption.

By the middle of January (the commencement of the rainy season) a parapet no where less than 6 feet high with a banquette as wide as the nature of the rampart allowed, was completed entirely round the place.

The gates were repaired and strengthened by buttresses; two of them were retrenched and a ditch carried round the north west angle, while some of the most dangerous ravines were laid open to our fire, and roads were opened into the low ground on the north side.

By the middle of February the ditch was carried round the place, with as good a covered way as the size of the ditch and supply of earth allowed, while the mosques, forts, gardens, and cover of every description had been destroyed for several hundred yards round the place.

At this time Mahomed Akbar Khan moved into the valley in order to attack the place; but they were unable to effect more than a distant investment: they frequently occupied the rocks on the south west, but the parapets and traverses rendered their fire harmless.

On the 19th February an earthquake, which nearly destroyed the town, threw down the greater part of our parapets, the Cabool gate with the two adjoining bastions, the north west bastion, and a part of the new bastion which flanked it. Three other bastions also were nearly destroyed while several large breaches were made in the curtains; one on the Peshawur side 80 feet long, was quite practicable, the ditch being filled and the ascent easy. Thus in one moment the labors of three months were in a great measure destroyed.

No time, however was lost: the shocks had scarcely ceased when the whole garrison was told off into working parties, and before night, the breaches were scarped, the rubbish below cleared away, and the ditches before them dug out while the great one on the Peshawur side, was surmounted by a good gabion parapet.

A parapet was erected on the remains of the north west

Digitized by Google

bastion, with an embrasure allowing the guns to flank the approach of the ruined Cabool gate; the parapet of the new bastion was restored so as to give a flanking fire to the north west bastion, while the ruined gate was rendered inaccessible by a trench in front of it, and in every bastion round the place a temporary parapet was raised.

From the following day all the troops off duty were continually at work, and such were their energy and perseverance that by the end of the month the parapets were entirely restored, the Cabool gate again serviceable, the bastions either restored or the curtain filled in when restoration was impracticable and every battery re-established.

The breach having been built up with the rampart doubled in thickness, and the whole of the gates retrenched.

It is not easy to give an adequate idea of the extent of the labour performed by the troops.

The parapets, banquets, &c., are built of the ruins of the buildings thrown down, cemented with clay mixed with straw and bound together, when requisite by bond timbers; of this masonry above 104,500 cubic feet had been built before the earthquake, and since then, (including new works,) about 103.900 cubic feet have beeu erected, making in all above 208,000 cubic feet of masonry. But the material had to be procured from a distance by the laborious process of demolition, and the ruinous wall had to be scarped, cleared at the base, and prepared for the work.

The quantity of walls of forts, mosques, gardens, &c. destroyed was considerably more than double that of the walls of the place, and the excavation from the ditch exceeds 860,000 cubic feet.

In addition to this, the troops had to build barracks for themselves and guard rooms round the works, each corps undertook its own barracks while the construction of the guard rooms was superintended by Captain Moorhouse, Quarter Master of Brigade, and Lieutenant and Quarter Master Sinclair* of her Majesty's 13th Light Infantry, whose assistance on this point left me more leisure for the defensive works.

* To Lieutenant Sinclair also we owe the mill used by the Commissariat, I only furnished materials and workmen. The credit of the whole contrivance and construction is due solely to Lieutenant Sinclair.
(Signed.) G. B.

Digitized by Google

The working parties in emergencies consisted of all men off duty, often assisted by the guards when the works were near their posts.

On ordinary occasions they consisted of all the Sappers and Miners, about 200 men of Her Majesty's 13th Light Infantry, 120 of the 35th Native Infantry, a party of Artillerymen of Captain Abbot's battery, all the men off duty in Captain Backhouse's mountain train, and the detachment of the 6th Infantry, Shah Soojah's force doing duty with the mountain train. Detachments also of Camp followers were employed in bringing material, &c.

Nothing could exceed the cheerful energy of every officer and man in these labours.

The Sappers and Miners worked from day-break to sunset with 2½ hours for meals, and, when occasion required, at night. Their conduct was such as to leave me nothing to desire, and it has been honored with the Major General's recorded approbation.

Lieutenant and Adjutant Orr and Lieutenant and Quarter Master Cunningham, who acted as my assistants, rendered me the most zealous and efficient aid; and I beg most respectfully to bring their great merit to the Major General's notice. The European Non-commissioned Officers also displayed a zeal and intelligence deserving to be reported to the Major General; more especially Serjeant Major Kelly, Quarter Master Sergeant Bruen, and acting Staff Serjeant Hughes, (from Her Majesty's 13th Light Infantry.)

The other troops having very severe garrison duty laboured for a shorter period, yet seldom less than six hours a day.

It will be seen that the largest parties were furnished by Her Majesty's 13th LightInfantry,and I know not how adequately to express my sense of the services of this admirable body of men; though having little more than every other night in bed they laboured for months day after day, Officers and men, with a cheerfulness and energy not to be surpassed. To enumerate all whose zeal and intelligence were conspicuous would almost require me to go over the list of the Officers,and to mention even many of the valuable Non-

Digitized by Google

commissioned Officers; but I cannot deny myself the pleasure of naming those whose more extended professional education gave their aid additional value, namely, Captain Fenwick, Lieutenant Frere, and Ensign Parker. Separate portions of the works were also entrusted at various times to other Officers, especially Lieutenants G. King, and G. Wade, and Ensign Scott, and I have every reason to be satisfied with their execution.

The 35th Native Infantry were much employed in destroying the forts and other cover around the place, and it is due to Captain Seaton to mention his great activity, and the skill with which, by directing the water-courses used for irrigation on the most massive ruins, he effected a quantity of demolition, which, with our short supply of Gunpowder would have otherwise been impracticable.

With the exception of a few of the larger bastions, the whole of the batteries were prepared by the Artillery themselves, (both Captain Abbott's battery and Captain Backhouse's mountain train,) under the superintendence of their own Officers. Besides this, a party of Captain Abbott's Artillerymen was always ready to assist in the works generally, and they were most ably superintended by Lieutenant Dawes to whom I am indebted for aid as constant as it was valuable, and willingly given. Captain Backhouse with his own men and detachment of the 6th Infantry, Shah Soojah's force, not only prepared the parapets and embrasures for his own guns, and repaired the damages done to them by the earthquake, but he undertook and completed several of the most useful and laborious operations executed: among others a large and widely branching series of ravines giving cover to many hundred men, within pistol shot of a very weak part of the works, was filled up, or entirely laid open to fire, and that with a number of men, which without his untiring zeal and personal exertion, would have been inadequate.

The camp followers were distributed to assist the troops and they followed the example set them and were extremely useful.

Appended are two plans and some sheets of sections.* The first plan shews in some measure the way in which the space round the fort was originally encumbered by buildings and enclosures. The second gives an outline of the place as it now stands, while the sections will give some idea of the

* Not received.

Digitized by Google

profile of the works as we found them and as we leave them.

The gates have been retrenched inwardly, because from the fall of the ground outside, and its conformation, no adequate work could have been raised, without a labour we could not at the time spare, and without occupying more time than we could ever reckon on for unmolested work.

The narrowness and shallowness of the ditch are owing to our want of tools, which limited the strength of our working parties so much, that any thing stronger could not have been carried round in time to accomplish our object—that of interposing an obstacle to a sudden assault and escalade on every side, while the enemy were still numerous and elated by the Cabool disasters.

The breadth of the berme was necessary from the nature of the soil, a loose sand ; and it varies as the necessity of including previous excavations, &c. obliged us to alter the tracing.

In conclusion, I have to solicit the Major General's indulgence for this report, which has been prepared while suffering from a wound. If I have been diffuse in noticing the assistance received from the Officers and troops, it must be ascribed to the admiration with which I daily, for many months, witnessed their labours, under circumstances of extraordinary discouragement, on short allowance of provisions, with heavy duties of other kinds to perform, and, for a considerable time, harrassed by incessant conflicts with the enemy ; during all this time there was not only no murmuring, but the utmost cheerfulness and zeal prevailed. It was not once necessary to resort to punishment, and I never had to make a single report other than commendatory.

BRASS GUN OF THE SHIP "ROYAL GEORGE."

A 24 pounder brass gun of 51 cwt. bearing the makers name. "A. Schalch, 1743," and the arms of the Duke of Montagu, (as the Master General of the Ordnance, when the gun was cast,) in addition to the Royal arms of George the Second, has been mounted on a carriage made from the wood, of the Royal George, and placed on the platform of the Queen's Bastion. The inscription on the gun is as follows :—"This gun formed part of the armament of the

Digitized by Google

" Royal George, sunk at Spithead in 1782, and recovered " from the wreck by J. A. Dean, in 1834." On the carriage is inscribed :—" This carriage was made of the wood " recovered from the wreck of the *Royal George*." Wool- " which 1842."

PERCUSSION SHELLS.

At Woolwich on the 24th of June, Mr. H. Reece, Mr. Napier and Mr. Tuck, inventors of Percussion Shells, and a number of their friends, amongst whom were Mr. Faraday, the celebaated chemist, and Mr. Gurney, the inventor of the Bude light; attended at the marshes to witness the experiments with these shells. Mr. Reece had twelve 32 pounder shells, Mr. Napier twelve 68 pounder shells, of the usual spherical construction, and Mr. Tuck six 32 pounder shells, and six 6 pounder shells for light field guns, both sizes cast in a sugar loaf form, having four grooves along the greatest diameter tapering in the hollows, so as to present as small a surface as possible next the charge of powder, and allowing a considerable space for windage in the action of discharge. Captain Palliser attended at the guns and Lieutenant Bland had the charge of the range to insure that the river at that part, was clear of vessels at the time of firing. Mr. Reece's 12 shells on being fired, all burst with one exception at the mouth of the guns, seven shots having been fired from one gun, and five from another. The shell that did not burst at the mouth of the gun struck the target, but did not explode. Mr. Napier's first, second, third, fifth, sixth, seventh, eleventh, and twelfth shells burst at the mouth of the gun, the fourth and eighth struck the target, but did not explode; and the ninth and tenth were the only shots in any way near the mark, as they exploded on striking the target. Mr. Tucks first, second, third and fourth shells did not burst, and the sixth exploded at the mouth of the gun. The fifth shell struck the target and exploded as it passed through it. The result of the experiments has been by no means equal to those carried on last year, as three effective explosions out of thirty is a very small proportion, and shews that the percussion principle, so far as it has been tried on large shells, cannot be placed in competition with the common fuze, at present used in the service. The firing was excellent when the shells did not burst in or at the mouth of the gun. The range was 400 yards.

Digitized by Google

MEMORANDA CONNECTED WITH THE MANUFACTURE OF GUNPOWDER AT ISHAPORE POWDER WORKS BY MAJOR T. TIMBRELL, 16TH JULY, 1842.

Saltpetre 1st Boiling.—The Crude Saltpetre as received from the Bazar is put into the boilers without any previous washing. In the proportion of about 32 Maunds of Saltpetre to 40 Maunds of tank water. This is what one of our boilers will contain and we continually use 8 of these Boilers. They are filled during the day and a strong fire being made under each pair of Boilers at 8 o'clock at night, the solution is brought to a brisk boil by 6 in the morning, when the fire is withdrawn, and all impurities that have risen are skimmed off. and a quantity of a solution of what is here termed potash, is thrown into each boiler, which checks the ebullition, causes the lighter impurities to rise, and the muriate of Soda and other heavy impurities to subside, for which, the solution is left an hour or somewhat more in the boiler, when it is pumped off into large vats and left there 3 hours to settle, and then drawn off by Brass cocks, fixed near the bottoms of the vats, into wooden cisterns, 15 or 16 feet square and 18 Inches deep, and into copper Crystalizing Pans 26 to 30 inches diameter and 10 inches deep. In the cisterns, the Crystals are not well formed in less than three days, but in the pans in 24 hours, when the water is drawn or poured off and taken to the evaporating pans or boilers, and the Crystals, when well drained are put in the stores as once boiled. Generally about $\frac{2}{3}$ of this water has to be evaporated, before it is brought to a proper consistence to Crystalize, then pumped off into cisterns or pans and Crystalized same as before, some of these Crystals are of about the same purity as the crude, consequently are used and treated the same. This first boiling of saltpetre is of necessity always performed in the rainy season here for want of room and conveniences to do it when all the works are in operation. No Saltpetre sold here. The residium is sold which consists chiefly of muriate of Soda and other very impure kinds of salt. There is now 20,000 maunds or 1645, 700 of lbs being got through the first boiling for next season.

Second Boiling.—The second boiling is performed in the same manner as the first, but to put about 4 maunds less of the first boiled Crystals into each boiler, than was put in of

Digitized by Google

Crude. Fire made at night, ready early next morning. Pumped off into the vats, drawn off into Crystalizing pans, and left for 24 hours as before, when the water is poured off and the pans set on edge for the Crystals to drain, and when drained they are beat fine on wooden platforms, and then twice washed in large cisterns with tank water, and afterwards washed in small quantities in the Crystalizing pans with distilled water, when it is put into baskets set in a draining trough, that holds 24 baskets, when more distilled water is poured or sprinkled over the Crystals, to carry off any remaining impurities. By this time the Saltpetre stands the test of the nitrate of Silver. When the Crystals have stood 2 days in these baskets, they are taken to the fusing house, where 4 iron pots are fixed, each to contain from 450 to 500 lbs of Saltpetre, where it is brought to a state of fusion, or to the appearance of boiling water, when it is ladled off into pans similar to the Crystalizing Pans to cool, and harden into cakes, which it does in two days and is then taken to the pulverizing mills, that are nearly similar to the incorporating mills, only the cylinders are of solid pieces of wood joined together with a tire of iron 2 inches thick. They are 7 feet high and 16 inches broad on the face, with a bed of iron to work on, in the bed about 2 cwt. of saltpetre is put at a time, previously broken into lumps, when the mill is set a going, worked by 3 bullocks and a man with a wooden spatula to keep stirring the saltpetre, till sufficiently fine to be sifted, which is done by small hand sieves with bottoms of fine silk, and is then taken to the weighing and mixing house.

Fusing.

5 *Pulverizing mills, viz.*
3 *Saltpetre.*
1 *Sulphur.*
1 *Charcoal.*

Sulphur.—The sulphur is generally sufficiently pure with only once fusing, by skimming and subsiding, same as at Madras, putting only 6 cwt. in the boiler at once, but is pulverized by a mill and sifted same as the saltpetre when it is fit for use.

Charcoal.—The charcoal used in this manufactory for Gun Powder is prepared from Dhol wood, which is only procurable in the months of January, February, and March consequently a quantity must be purchased during those months sufficient to last till January of the succeeding season, which must be *stacked* and *covered* with at *least three coats*

Digitized by Google

of *mats*, and even then some rain gets into the stacks and rots some, and insects destroy much more. To use this wood, it is carefully picked, to separate every piece that has any appearance of the insects having attacked, or been injured by the rain getting to it. The wood so injured is thrown aside, to be used as fuel, and the *perfectly sound wood* is cut into pieces about 9 inches long, which are packed very close in a sheet iron cylinder to be charred, which is done by putting the sheet iron cylinder with its contents into a cast iron retort built in masonry with a fire place under it, in which a strong fire is made. To the front end of the retort are two round doors which fit a little way into it and outside of them is a sand door. The space between the circular doors and sand door is filled with sand to prevent the possibility of air getting to the wood while charring, which would cause it to be burnt to ashes instead of charcoal. In the rear end of the retort are two orifices, to which two copper pipes are attached to carry off the gas, tar, &c. It can be known when the wood is sufficiently charred, by the smoke becoming of a light blue colour, and very little smoke coming off, when the slip or sheet iron cylinder is withdrawn, taking *care to lute up every crevice where smoke appears to issue to prevent air getting to the Charcoal. There is never to be more charcoal made in one day, than will be used the next, and not to be taken out of the slip Cylinders, till required to be taken to the grinding or pulverizing mill*,* which is similar to those for Saltpetre and Sulphur, only that the bed and face of the Cylinders is of a white metal, instead of iron. Two maunds or 160lb of charcol, just as taken from the charring Cylinder, is put in the bed, and the mill put in motion by three bullocks, and when sufficiently ground is sifted same as the other ingredients, but the sieve rather coarser.

16 *cast iron retorts are fixed in masonry*, 8 *generally used, from which is got* 3 *charges daily.*

Weighing House.—The three ingredients are here weighed in the proportion of 75 parts of Saltpetre, 10 of Sulphur, and 15 of Charcoal, or as 80lb is a charge for mixing barrels and mills, we weigh 60, 8 and 12lb, which are mixed by wooden rollers on tables for a few minutes, and the 80lb of composi-

* The charcoal, whole or Pulverized, is apt to burn *spontaneously*, and great care is taken never to leave any in the sifting bins for it causes fire.

Digitized by Google

tion. with about 80lb of brass balls are put into each mixing barrel, which is kept revolving at the rate of about 20 revolutions per minute for 1¾ hours when the composition is taken out of the mixing barrels, the brass balls separated from the composition and, the composition carried to the incorporating mill; 10 mixing barrels require 40 men and supply 5 mills.

Incorporating Mills.—80lbs. of composition is put in the mill bed, at a time mixed with 4lbs. of distilled water, the mill put in motion and kept going to 160 revolutions, when about 1lb more water is given according to state or heat of the weather, and at 200 a little more water and then the mill is worked up to 240, when it is stopped and the charge taken out. There are two men with wooden spatulas turning and stirring up the composition in the bed all the time the mill is going, there are here five mills, which can each mill 12 charges of 80lb in the 24 hours, except that one mill is occupied 6 or 8 hours milling the dust from corning and sifting houses, which is milled separate by charges of 80lb put in the bed with about 2lb of distilled water, and 40 revolutions given to it, when it is taken out and mixed with the fresh composition. The mills here are same as those at Madras. Four ploughs fixed in each. They work night and day from the commencement of the season in October, till the quantity ordered is completed, generally in May. The last season the outurn was 9290 barrels of 100lb each. There are register clocks in the mills which shew the number of revolutions the Cattle have made. After the compo-

Bruising House. sition has received the usual milling it is taken to the bruising house, where a man with a large wooden roller breaks all lumps and pieces of cake that may have been formed by milling, to allow of the composition going free and even into the press boxes, where it is carried next.

Press.—The press consists of a very strong frame of wood, part of it sunk into the ground and built round with the best of brick masonry to keep it firm; in the upper transom or cross piece of which, is fixed a very strong and powerful iron screw worked by a capstan and strong rope, by means of a lever that fits into the head of the screw which gives the pressure, working into a strong box placed underneath it, into which the composition to be pressed is put, the box is 28

Digitized by Google

inches deep 27 inches long and 18 inches broad. There is no top fixed in it, and the front side moves on hinges. To fill the box, it is laid on its back, and the front side which has then become uppermost is opened, and 18 plates of sheet copper $\frac{1}{10}$ of an inch thick that just fit the box are placed in it, kept at equal distances by rods of wood $\frac{1}{2}$ inch square; the composition is then poured in and well drove down between the plates of copper, by thin wooden slices made for the purpose, when the rods are withdrawn and a little more composition rammed into the spaces they have left, when the side is closed and the box set on its proper bottom under the screw, with a set of false cheeks that fit to the four sides of the box, and are tightened to it by screws fixed in the frame, when the pressure is applied by the capstan and screw till the 25 inches of composition put in the box is reduced in bulk to 13, and formed into very firm cakes. The screw is then eased back, the front of the box opened and the cake taken out, which has then the appearance of a piece of slate, and with a little hardening in the sun is ready for the corning machine. The press box holds 375lb of composition.

Corning House.—The press cake after being exposed to the sun and air for about 2 hours, is kept to be corned the next day, which is done as follows: the corning machine consists of a frame of a strong tough wood, in which are placed five pairs of brass rollers (toothed) with several brass wheels to work them. The cake is passed between these rollers which reduces it to grain, and some of it to dust. There is a large seive under the machine kept in motion by the same power that works the machine, one pair of bullocks. All that is broke fine enough for the grains of powder, passes through the sieve and is received in small barrels underneath it, and the parts that are not broke fine enough, are carried back on elevating bands worked by the machinery to be passed again through the rollers. As the small barrels under the sieve are filled, they are carried to the sifting house, where the ordnance and Musketry Powder are separated by passing through brass wire sieves of different degrees of fineness, and the dust returned to be remilled. The large sieve under the corning machine has a bottom of brass wire cloth 13×13 meshes to the square inch, and what passes through that, and will not pass through one of 24×24 is ordnance powder, and what passes through one 24×24 and will not pass through 34×34 is musketry powder.

Digitized by Google

Glazing House.—The powder is then sent to the Glazing house, where the whole is glazed by puttiug 100lb of powder into a skeleton rib barrel covered with coarse canvas, these are turned on their axis for three hours which gives a slight polish to the grains and at the same time extracts the dust. The glazing reel or barrel is 3 feet 10 inches long and 14 inches diameter inside, formed by 8 ribs the whole length at equal distances and short pieces, from stave to stave to support them and keep the barrel in its proper form, with a head in each end same as the heads of powder barrels nearly, into which the ends of the long ribs are morticed, and to which the canvas is sewed and lashed, besides being sewed the whole length of the side. Two of these glazing barrels work in one large box, on brass gudgeons fixed to the heads of the barrels, and brass sockets in the framing of the box. One man turns each by a copper crank handle. There are 10 or 11 of these used every day in the working season.

Drying Terraces.—From the glazing house the powder is placed on the drying terraces, where it is exposed to the heat of *the sun* for *four* days, *taking care that awnings* are *put up over it*, if the *Thermometer rises in the powder to* above 130 *degrees.* After the musketry has been one day exposed to the sun, it is sifted again for dust, with a sieve 54×54 meshes to the inch and then dried for three days longer. When the powder is sufficiently dry, it is weighed into well aired dry barrels, one hundred pounds into each and made over to the Magazine of the Artillery Officer on proof duty from Dum Dum. The officer keeps it under his charge for one month, and then proves it with an 8 inch Gomer Mortar, charge 2ozs. Proof Picket 63 yards, Balls 67℔ 10 or 12 ozs.; on the powder standing proof the barrels are properly marked, and ordered to be delivered to the charge of the Principal Commissary of Ordnance Fort William.

The foregoing is a short Memo. of the modes of manufacture of gun powder at Ishapore at this time.

PYROLIGNEOUS TAR AND ACID.

Method of obtaining the Tar and Acid in the Bombay Powder Mills, by Major Jacob.

On the properties of Pyroligneous Tar & The greatest caution is necessary in condensing the smoke from the

Digitized by Google

Acid, and the mode of preparing them.

charcoal cylinders, so as not to drive back by a resistance to their exit, any of the gaseous products which would tend seriously to injure the charcoal for the purposes of the manufactory. The following instance referred to in Parker's chemical essays strikingly illustrates this.

"Some time ago, a very remarkable circumstance respecting the collection of pyroligneous acid from the charcoal cylinders, came to my knowledge, which I think worth recording, as it may preserve some individuals from great loss and disappointment, and must be of considerable importance to us as a nation."

Liable under certain circumstances to injure the charcoal on the purposes of Gun Powder.

"A Gentleman of opulence residing near the metropolis, who was the proprietor of some large gun powder works, and who prepared his own charcoal for that manufactory, sustained a considerable pecuniary loss from the following occurrence."

"He had for some time been collecting a portion of the pyroligneous acid, which arises from the wood in the act of charring; when a certain chemical adventurer persuaded him to make an alteration in the apparatus, with the view of procuring, as it was pretended, more than double the quantity of acid."

"According to this advice, he put up at a considerable expense an entirely new apparatus, which was so constructed that the pipes which conveyed the acid, as it arose from the ignited wood, *passed through a large body of water** which so completely cooled it, that the whole of it was condensed and collected in the recipient. In the last pipe, exactly at the place where it emerged from the water, there was a small hole, to prevent any part of the apparatus from bursting. Whenever the cylinders had done working, it was directed that this hole should be firmly stopped, and that then the whole apparatus should be suffered to cool."

A mode of increasing the condensations of the smoke in obtaining a greater quantity of acid and tar.

* Query—Did the pipe pass through the water like the worm of a still.

Digitized by Google

" By this arrangement a much larger quantity of acid was " preserved, as the adviser had predicted, and which pro- " mised an ample repayment of the expense of the altera- " tion ; but it was quickly perceived that the gunpowder " was very much deteriorated, and this happening at a time " when the house had a contract with Government, (in " which case the gunpowder is always accurately proved) " several parcels were complained of, " and one large delivery was actually " returned as unfit for the public ser- " vice."

Attended with serious injury to the gunpowder.

" These complaints were not only unexpected but pecu- " liarly mortifying, because the Manufacturer had been " pleasing himself with the idea that the gunpowder would " be improved, and he could not at all account for the " cause of this unfortunate change in the quality of his " article."

" At first he suspected that the nitre might contain " some deliquescent salts, but even when he had made his gun- " powder from the nitre which had been refined at His Ma- " jesty's private works where the utmost care is taken in the " process, the powder was still the same. Then the sulphur " was examined, and when nothing amiss could be dis- " covered, then, he began for the first time, to suspect that " the fault must be in the charcoal, although that which " they were then using was in appearance finer and hand- " somer than any they had ever had."

Deterioration in the powder attributed to the use of the defective apparatus on burning the charcoal.

" The proprietor was now, however, " convinced that the alteration in the " quality of the powder could not possi- " bly be otherwise accounted for, than " by attributing it to this alteration in " his apparatus ; he therefore instantly " ordered the whole to be removed, and " reverted to his old plan of distillation, by which one third " at least, of the acid is dissipated in gas, and entirely lost. " But the consequence was evidently favourable, and the " error fully detected. The gunpowder manufactured since, " is as good as it had formerly been, and received no more " complaints."

A remedy suggested by Mr. Parke.—" This circumstance " was not mentioned to me until after the new apparatus

Digitized by Google

" was destroyed, or I certainly would have advised the " proprietor to *continue the new arrangements*, and *to make* " *no other alteration than merely to provide the means for* " *the inconsiderable gaseous product to be properly dissi-* " *pated.* For, by stopping up the vent hole, the latter por- " tions of the incondensable gas could not get away : and " every chemist knows the property which charcoal has of " absorbing with avidity all the gases, and in considerable " quantity. If instead of stopping up the vent hole, several " others had been opened *during the last stage of the pro-* " *cess, and suffered to remain so while the cylinders were* " *cooling*, I doubt not that this charcoal would have turn- " ed out equal in goodness to the former."

The evil anticipated and guarded against by the Agent for gunpowder at Bombay.

It will be seen that I had anticipated the evil pointed out by attaching stop cocks to the receiver in the Bombay experiment and that it therefore entailed none of the ill consequences mentioned in the foregoing account given by Mr. Parke. The plan of the apparatus recommended by Parke is shewn in fig. 37.

I am not aware of there being at present any demand in the local market for Pyroligneous acid, such as ensures so remunerating a return for the expense of preparing it in England. The tar deserves, I think, a better character than that given to it by the Chief Engineer of Bombay, and as its merits do not appear to be as yet known, I beg to append the following notice of it extracted from Parke's Essays.

" This method of working (in cylinders) does, however, " produce better charcoal for gunpowder, and it has the ad- " vantage of furnishing a large supply of an impure kind of " vinegar, or acetic acid, which is very useful in several of " our manufactories. The acid was formerly considered to " to be of a peculiar nature, and distinct from all others ; " it was named the pyroligneous acid and in commerce it is " still known by that appellation. Before this acid begins " to distil over, there comes a peculiar fluid called naphtha, " or pyroligneous ether, which is used, when purified, by a " subsequent distillation with lime and animal charcoal, for " spirit lamps, for the solution of shellac and the gums, and " indeed for most purposes in which alcohol was formerly " required ; but at present the greatest consumption is by " Mr. Mackintosh in dissolving caoutchouc (Indian Rubber)

Digitized by Google

" for the preparation of his water proof, and air proof " cloth, for great coats, cloaks, &c. and indeed to such per- " fection has he now brought it, that he makes air-tight " pillowcases and beds, which only require to be blown full " of air by the mouth, to be ready for use when required, " and in the morning the air may be let out and the bed " folded up and put away into the traveller's trunk.

" When this acid is suffered to stand a few weeks undis- " turbed, it deposits a peculiar kind of tar, and this in con- " siderable quantity. Every kind of wood will produce this " acid and tar, when treated by what is called the destruc- " tive distillation—Peat also will yield it in abundance " —a Friend of mine distilled some which was dug in " Whalmer Forest, and procured pyroligneous acid from it. " When this acid was re-distilled, it left a residuum of " tar, similar to that which is produced from the second distillation of wood acid. For some years past this tar has been a great burden on the hands of those who have been largely concerned in making the " pyroligneous acid. For though it has been employed in a " great variety of ways, the consumption has never kept " pace with the quantity produced and within my own " knowledge many tons of it have been buried in the earth, " merely to get rid of it."

Pyroligneous tar formerly considered useless.

" It was tried in one of the public dock yards ; but the " quantity produ- at that time in Great Britain was, in " comparison with the quantity of pitch " and tar required for the Royal Navy, too insignificant to permit the idea " to be ever entertained of its being gener- " ally used in the Government dockyard, particularly as it " will not combine with the imported pitch and tar in " common use."

Its quantity subsequently ascertained by experiment.

" I have myself in various ways, made experiments upon " this tar, and notwithstanding this inconvenience, I am so " convinced of its value, that I am desirous of making it an " object of public attention.

" For every kind of wood fence it is the best preservative " of any thing that can be applied. It " should be gently heated in an iron " pot, and put on with a brush. When " first put on, it gets so completely into " the wood, that it might be supposed " that it could be of little use. It soaks

The preserving qualities of the pyroligneous tar as applied to exposed wood work.

Digitized by Google

" in, and seems to leave no body, as the artists express it ; " but if the work thus treated be examined after it has been " exposed for some days to the sun, the surface and the " texture of the wood will evidently be much altered ; for " it will now be found so impervious and hard, that it will " be very difficult to make any impression upon it.

Two or three coats of tar recommended.

" If a second, and especialy if a third coat of this tar be " put upon wood, it will then bear out, " as the painters call it, sufficiently well ; " and I have reason to believe, that it " will preserve all outside wood work " much more effectually, than it can be preserved by any " other expedient that has hitherto been contrived for this " very important purpose.

" For ornamental paling, and indeed for all good outside " work, a first, or perhaps a first and second coat of this tar " might be used with great advantage, and when these shall " be completely dry, the work might be finished with white " lead and oil as usual.

The extraordinary qualities of the tar.

" Besides the extreme hardness which this article imparts " to wood, it has also the advantage of effectually preserving " it from worms and all other insects. Even where wood has " become worm eaten, I have observed this tar will stop the " progress of the decay ; and I am inclined to think from " what I have seen that a paling of worm-eaten deal, if it " be not absolutely rotten, will last longer " when covered with this article, than a " similar fence made with new deal with- " out such treatment. It may however " be necesary to remark, that the article here spoken of is " very different from the tar which is distilled from mineral " coal, and that was recommended by the Earl of Dundon- " ald, thirty years ago, for a similar purpose.

" To those persons to whom a little additional expense " would be no object of consideration, the following prepa- " rations are recommended : they will be found to improve " the appearance of the wood to which it is applied very con- " siderably 1 gallon of the tar, 1 oz. of tallow, and 2 ozs. of " pulverized resin, melted together and put on warm ; or " 1 gallon of the tar, and 2 oz. of pulverized sulphate of " iron, to be used in the same manner as the foregoing " mixture.

Digitized by Google

"The first of these prescriptions looks the best, but the "latter has been proved, and has lasted good for twenty "years. How much longer it will be an effectual preserva- "tive for the wood, time only can discover.

Pyroligneous tar excellent as a varnish.

"I have occasionaly made many other trials of the tar "from pyroligneous acid, and I find it "useful not only for wood, but also as a "varnish for a variety of goods made of "rolled iron, or of cast iron. A more "beautiful varnish for these purposes may however be "prepared by the following process. Take 1 gallon of the "wood tar, and ½ pint of rectified spirits of wine, and let "these be intimately mixed by a gentle heat.

"If this composition be laid on hot and properly har- "dened by the air, it will prove a beautiful and durable "black varnish."

The sketch, Fig. 38, exhibits the apparatus I adapted to our Cylinders for the condensation of Pyroligneous acid and tar in Bombay.

Instead of stop cocks I would now recommend holes being made in the lid of the receiver and wooden plugs fitted to them, as cocks are expensive and are apt to get out of order.

An experiment with Parke's method recommended.

I am not quite sure whether the wrought sheet iron receiver is indispensable, but it appeared to me to be desirable with the view of averting all danger to the quality of the charcoal. It will be seen that the openings in our cylinders are fixed horizontally. I would suggest that they should be altered so as to be vertical, one at the top and the other at the bottom of the end of the cylinder, and that, by way of experiment, an apparatus, precisely similar to Parke's sketch, be resorted to, as it can easily be made and will cost but little. As I understand it, the casks are empty and the smoke does not pass through water as in a Woulf's apparatus, at least I cannot gather from Parke's description of it, that it does so. It could however easily be tried first without water, and if found to answer it could be permanently adopted for this manufactory, the disadvantage of making the smoke force its way through water is, that without a safety valve

Digitized by Google

Digitized by Google

Miscel

S

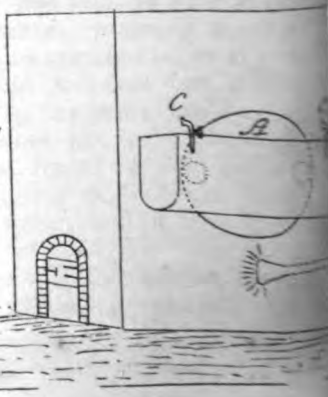
Parke's Apparatus for cond
from the smo

A.... Furnace.
B.... End of cylinder for
charring the wood.
C.... Fire-place.
D.... Tar receiver.



Apparatus adopt
works at Bombay
gestion, for conde
Tar from the Sl

A.. End of three Slip Cylinders.
B.. The Receiver
C.C.C.. Stop Cocks
D.D.D. Pipes admitting the Acid,
the tar and smoke into
the condensing barrels



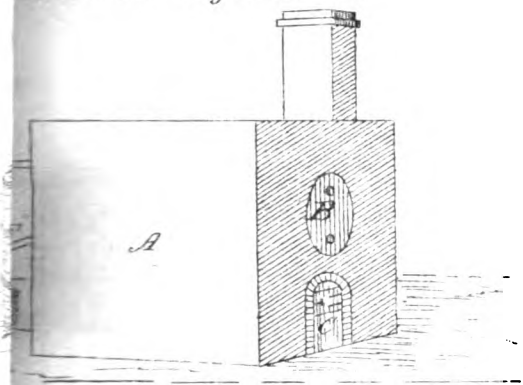
Artil.y Depôt lith.?

Digitized by Google

...eous.

...g Pyroligneous Tar & Acid

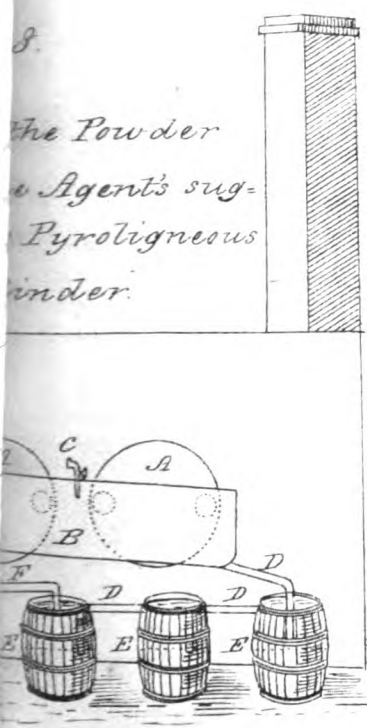
...harcoal Cylinders.



E....Acid Pipe
F.....Tar Pipe
H.....Acid Casks
I.....Adapters.

...8.

...the Powder
...e Agent's sug=
...Pyroligneous
...inder.



EEE. Condensing barrels half filled with water.
F..... Pipe for returning the carburetted Hydrogen gas, to be burnt in the furnace.

E. F. E.

Digitized by Google

Digitized by Google

to allow of its ready escape when the resistance happens to be too great ; it would be forced back again upon the charcoal in the cylinders and injure it. It was a desire to avert the possibility of this alternative, that suggested to me the advantage of a large receiver as shewn in the sketch, with stop cocks to adjust the escape of the smoke *at the latter end of the operation, when ceasing to issue from the cylinders with sufficient force to overcome the resistance of the water, and* I incline strongly to the advantage of this mode of proceeding from the satisfactory results it gave. The pyroligneous acid however must have become incorporated and so diluted with the water in the casks as to be scarcely discoverable in one day's operation. It would thus appear that the same water should be very long continued in the casks, in order to its becoming sufficiently impregnated or saturated, to allow of the acid being obtained in a pure state by one subsequent distillation. At the bottom of each cask a quantity of tar will be found daily to accumulate, as well as in "the receiver ;" and it should be daily removed into barrels for sale or use. The flat top of "the receiver" should be made to open or lift off so as to allow of the receiver being cleansed when required. It should slope a little towards "the condensing barrels" to let the limped portions of the tar run down into the barrel as shewn in the sketch.

Mode adopted by the powder Agent at Bombay with success.

BURSTING OF MONK'S GUN.

On Thursday the 7th July, during the time the experiments with large guns at long ranges were being carried on, one of Mr. Monk's guns, a 56-pounder, weighing 97 cwt., burst into four pieces when the fifth round was fired, and injured, but only in a very slight degree, five persons ; a Corporal and two Gunners and drivers of the Royal Artillery, and two men belonging to the preventive service who were present as spectators. At the time the gun burst, it was calculated there could not have been less than 700 persons present to witness the firing, and it was most providential that a great destructoin of human life did not occur in con-

Digitized by Google

sequence of the accident. No blame whatever could be attached to the gun, or the principle on which it was constructed, as it stood the original proof test in the most satifactory manner, and had been fired about 150 times since. So far as the experiments have been made, they have proved satisfactory ; but the bursting of this gun has shown, that to be made with safety, long ranges can only be obtained by a species of ordnance constructed for that purpose with great solidity of metal at the breech. The usual elevation to which the guns on the present construction are applicable varies from one to ten degrees, according to the range, which affords ample room for recoil ; but an elevation up to 25 degrees necessary to convey a ball a distance of upwards of three miles, must be liable to danger, unless the guns are of the most powerful nature at the breech, as they have scarcely any recoil, the tendency of the firing at that elevation being to sink them into the earth.

MONSTER GUN FOR MAHOMED ALI.

On Friday the 22d July at noon, the large 455 pounder gun for Mehemet Ali, was proved at the butt and found perfect. The charge of powder with which it was fired, was 65 lbs. weight, and the shell 330 lbs. weight. The second charge of powder was 45 lb. for the solid ball of 455 lb. weight. The reports from this immense Ordnance gun were not so loud as might have been anticipated from its magnitude ; but the effect of the shell and ball was tremendous, scattering a great body of the earth of the butt to a considerable height, and shewing, on examination, that the propelled forces had entered the butt to the extent of about forty feet—a rent of about two inches on the top, where the earth had fallen in after the concussion, distinctly marking that it had been perforated to that distance. The diameter of bore is 15·3 inches, and the shell contains 30 lbs. of bursting powder. This gun as well as some 130 Pounders, are for the Pacha of Egypt, and of Mr. Monk's construction, they are for coast defence, and though so large, are exceedingly elegant in shape, and objects worth seeing by the curious.

Digitized by Google

LOVELL'S SUGGESTIONS FOR THE CARE AND MANAGEMENT OF PERCUSSION ARMS.

Plates 42—43—44.

PERCUSSION MUSQUET OF THE LINE.

Fig. 1.—The barrel, reduced to one-seventh size—*a*, the breech; *b*, the nipple seat or lump; *c*, the back-sight; *d*, the back-loop; *e*, the middle-loop; *f*, the swivel-loop; *g*, the front-loop with the bayonet spring attached; *h*, the front sight; *i*, the muzzle.

Fig. 2.—The breech-pin, half size—*a*, the tang; *b*, the neck; *c*, the screw-threads; *d*, the face.

Fig. 3.—The bayonet-spring, two ways, half size—*a*, the shank; *b*, the neck; *c*, the hook; *d*, the mortice.

Fig. 4.—The nipple, full size—*a*, the cone; *b*, the squares; *c*, the shoulder; *d*, the screw-threads; *e*, the touch-hole.

Fig. 5.—The rammer, reduced to one-seventh size—*a*, the head; *b*, the shaft; *c*, the screw-threads.

Fig. 6.—The lock outside, half size—*a*, the plate; *b*, the cock; *c*, the tumbler-pin; *d*, the hollow for the nipple-seat.

Fig. 7.—The lock inside, half size, showing all the parts in their places with the cock down at bearer—*a*, the main-spring; *b*, the sear-spring; *c*, the sear; *d*, the tumbler; *e*, the bridle; *f*, the main-spring pin; *g*, the sear-pin; *h*, the sear-spring-pin; *i*, the bridle-pin.

Fig. 8.—The plate, half size—*a*, the nib; *b*, the axle-hole; *c*, the front side-nail hole; *d*, the hind side-nail hole; *e*, the sear-pin hole; *f*, the sear-spring-pin hole; *g*, the bridle-pin hole; *h*, the bridle-stud hole; *i*, the main-pin hole; *k*, the main-spring stud hole; *l*, the sear-spring-stud hole.

Fig. 9.—The cock, half size—*a*, the body; *b*, the neck; *c*, the head; *d*, the comb; *e*, the mouth; *f*, the square of the tumbler hole.

Fig. 10—The tumbler, two ways, half size—*a*, the axle; *b*, the squares; *c*, the pivot; *d*, the hook; *e*, the half-bent; *f*, the whole-bent; *g*, the bearer.

Fig. 11.—The bridle, two ways, half size—*a*, the pivot-hole; *b*, the sear-pin-hole; *c*, the bridle-pin hole; *d*, the stud.

Digitized by Google

Fig. 12.—The sear, two ways, half size—*a*, the eye, or sear-pin hole; *b*, the neck; *c*, the shank; *d*, the arm; *e*, the nose.

Fig. 13.—The sear-spring, twoways, half size—*a*, the eye: *b*, the stud; *c*, the return; *d*, the spring.

Fig. 14.—The main-spring, two ways, half size-*a*, the eye; *b*, the return; *c*, the stud; *d*, the spring; *e*, the hook; *f*, the toe.

Fig. 15.—The lock-pins,full size—*a*, the sear—pin; *b*, the bridle-pin; *c*, the sear-spring-pin; *d*, the main-spring-pin; *e*, the tumbler-pin.

Fig. 16.—The bayonet, quarter size—*a*, the socket; *b*, the ring; *c*, the motion; *d*, the neck: *e*, the blade.

Fig. 17.—The stock, one-ninth size—*a*, the butt; *b*, the hand; *c*, the head; *d*, the swell; *e*, the shaft.

Fig. 18.—The heel-plate, quarter size—*a*, the stud; *b*, *b*, wood-screws; *c*, the strap.

Fig. 19.—The trigger-plate, two ways, half size—*a*, the trigger-pin-hole; *b*, the box; *c*, the breech-nail boss; *d*, the mortice.

Fig. 20.—The trigger half size—*a*, the axle-hole; *b*, the lever; *c*, the finger; *d*, the trigger-pin.

Fig. 21.—The handle or guard, quarter size—*a*, the stud; *b*, the bow; *c*, *c*, the wood screws.

Fig. 22.—The long or trumpet-pipe, half size—*a*, *a*, the studs; *b*, the pipe.

Fig. 23.—One of the short pipes, half size—*a*, the stud: *b*, the pipe.

Fig. 24.—The nose-cap, half-size-*a*, the cap; *b*, the bridge.

Fig. 25.—The handle-swivel, half-size—*a*, the bow; *b*, the pin; *c*, the neck; *d*, the bend.

Fig. 26.—The shaft-swivel, half size—*a*, the bow; *b*, the pin; *c*, the neck; *d*, the bend.

Fig. 27.—The rammer-spring, half size—*a*, the wire-pin-hook; *b*, the spring.

Fig. 28.—The bolts, half size—*a*, the hind-bolt; *b*, the middle-bolt; *c*, the front bolt.

Digitized by Google

Fig. 29.—The side-piece, half size—*a*, the front side nail hole; *b*, the hind sidenail hole; *c*, the wood screw hole.

Fig. 30.—The nails, half size—*a*, the breech nail; *b*, *b*, the side-nails.

Fig. 31,—The lock-cramp for main-springs of all locks, half-size—*a*, the slide-bar; *b*, the hook; *c*, the fly; *d*, the screw; *e*, the bolt, and nut.

Fig. 32.—The nipple-wrench, half size—*a*, the wrench for the nipple; *b*, the broad turnscrew for side and breech nails; *c*, the lever with worm attached; *d*, the picker; *e*, the narrow turnscrew for the lock-pins of back-action locks.

Fig. 33.—The muzzle stopper, half size. *a*, the cap; *b*, the wooden-spring-stopper.

Fig. 34.—The sear spring-cramp for back action locks, half size—*a*, the bar; *b*, the lever; *c*, the hook of the bar; *d*, the fly.

To Dismount the Musquet.

1st. Unfix the bayonet (16). 2nd, Put the stopper (33) or a plug of wood, into the muzzle of the barrel (1, *i*). 3rd, Draw the rammer (5). 4th, Unbuckle the sling. 5th, Pull the cock (9) up to the half-bent of the tumbler (10,*e*). 6th, Unscrew the pin of the shaft-swivel (26,*b*): in doing this, press the point of the screw against a table, post, or other wooden substance, so that the pin may follow the turnscrew (32,*b*); otherwise, if the pin should bind in the stock, when you turn it round, the farther neck of the swivel will be forced outwards, and broken off at the bend (26,*d*). 7th. Start the bolts (28), by pressing on the points with the flat side of the turnscrew (32,*b*) until they go home to the wood; taking care not to bruise the stock. 8th, Draw the front bolt; then the middle-bolt; and, lastly, the hind-bolt; in doing this, hold the head of the stock (17,*c*), firmly between the knees, put the end of the turnscrew flat under the bolt-head, and pull with a stiff hand, until the bolt comes half-way out, when the force should be eased, so as not to bring the bolt up against its wire-pin with a jerk which might splinter the shaft (17,*e*). 9th, unscrew the breech-nail (30,*a*) and take it out. 10th, Take out the barrel (1): in doing this, turn the musquet horizontally with the barrel downwards, holding the barrel loosely with the hand round the swell; and if it does not leave the stock, tap the plug of wood that is in the muzzle against the ground, which will

Digitized by Google

loosen the breech-end from the stock. This is better than lifting the barrel out by hand at the muzzle; because if the tang of the breech-pin (2,*a*) should bind in the wood, the head of the stock (17,*c*) is apt to be split when the muzzle of the barrel is lifted up forcibly. 11th, Unscrew the side-nails (30,*bb*), and take them out, drawing the front nail first, and then the hind one; if the lock should stick in the wood, a slight tap on the heads of the side-nails after they have been started will move it out. 12th, Take out the lock: in doing this, turn the musquet horizontally with the lock downwards, and it will drop out into the left hand by tapping the stock with the right.

To Dismount the Lock.

When it is absolutely necessary, but this need very seldom be the case if proper and regular care be taken of the arm.

1st, See that the cock (9) is in the half-bent of the tumbler (10,*e*). 2nd, Unscrew the main-spring-pin (7,*f*). 3rd, Take off the main-spring (7,*a*): to do this, put the hook of the lock-cramp (31,*b*) on to the upper side of the return of the main-spring (14,*b*), so that the end of the slide bar (31,*a*) may come close to the hook of the tumbler (7,*d*), but not so as to touch it; then screw up the fly of the lock cramp (31,*c*), until the bar takes the bearing of the main-spring; then hold the lock with the cramp on it by the left hand, the inside of the lock towards you; pass the forefinger of the right hand over the comb of the cock (9,*d*) pulling it up until the toe of the sear (12,*e*) is relieved from the half-bent of the tumbler (10,*e*), by lifting the arm of the sear (12,*d*) at the same time with the right thumb; then let the cock down to bearer, as in Fig. 7; this will free the main-spring which may be taken off, and must be left with the lock-cramp attached to it. 4th, Take off the sear-spring. (7,*b*): to do this, unscrew two or three threads of the sear-spring pin (7,*h*), tap upon the lock-plate with a piece of wood, which will cause the stud of the spring (13,*b*) to rise out of the plate, or otherwise put the end of the turnscrew under the spring and lift it out of the plate; then unscrew the pin entirely and take it out, and the sear-spring 5th, unscrew the sear-pin (7,*g*), and take it out. 6th, Take off the sear (7,*c*), unscrew the bridle-pin (7,*i*), and take off the bridle (7,*e*), ; if the stud of the bridle should stick, tap upon the lock-plate with a piece of wood, and it will come out. 8th, Unscrew the tumbler-pin (6,*c*). 9th, Take off the cock (6,*b*): to do this, lay the lock-plate with the cock downwards on the palm of the left hand, and tap it off the

Digitized by Google

squares of the tumbler (10,*b*), by striking on the flat of the inside of the neck of the cock (9,*b*) with a piece of wood : (on no account is iron to be used.) The cock in this way will gradually leave the squares of the tumbler. 10th, Take out the tumbler (10).

N. B. If the cock fits very tight on the squares, as it ought to do, it is a difficult matter to take it off properly, without a proper drift punch and the help of a vice ; therefore, it should never, if possible, be attempted, because every time it is done tends to loosen it on the squares and spoil its action. The tumbler may be very well cleaned and wiped between it and the lock-plate, and underneath the body of the cock (9,*a*), with the edge of a linen rag, without disturbing the cock at all.

As the several parts of the lock are removed, they should be placed carefully together in a paper or other receptacle ; more especially if other arms are being cleaned in the same place ; so that they may not be lost or get intermixed.

None of the other fitments of the musquet, besides those before enumerated, should ever be taken off or moved, on any account, unless it be done by an experienced armourer.

The musquet being now taken to pieces as far as it should ever be done under ordinary circumstances, proceed—

To clean the Barrel.

Stop the touch-hole of the nipple (4,*e*) with a little peg of soft wood ; pour about a gill of water (warm if it can be had) into the muzzle of the barrel ; let it stand a short time to soften the filth of the powder ; put the wooden plug into the muzzle and shake the water up and down the barrel well ; pour this out and repeat the washing two or three times until the water comes out clear ; take the stopper out of the touch-hole, and set the barrel, muzzle downwards, upon a board or wooden floor to drain for a few minutes.

Screw the worm (32,*c*) on to the end of the rammer (5,*c*), and put a piece of dry rag or tow round it, so as to cover the horns well, and prevent them scratching or scoring the bore of the barrel ; wipe the barrel out quite dry, changing or drying the rag two or three times. Then, if necessary, turn out the nipple (4) with the nipple-wrench (32,*a*) : in doing this, take care that the wrench (*a*) goes well down over the squares of the nipple (4,*b*), otherwise they will be battered and the nipple spoiled.

Digitized by Google

Wipe the nipple clean inside and out, and clean the screw-threads in the nipple-seat (1,*b*), and the touch-hole into the barrel, with a rag that has been slightly oiled put on the end of a small piece of wood or a feather; but never use any thing harder than wood.

When the screw-threads of the nipple (4,*d*) are quite dry and clean, touch them with a small quantity of olive or sweet oil; turn the nipple into the nipple-seat two or three threads of the screw with the finger and thumb lightly, that you may be certain it has entered fair, and then screw it home with the wrench, taking care that no grit or dirt gets between the shoulder of the nipple (4,*c*) and the face of the nippleseat (1,*b*). Do not put oil in the touch hole of the nipple (4,*e*), nor leave the hole into the barrel clogged with oil, because this is almost certain to cause the first cap to miss fire. Lastly, put a piece of slightly oiled rag round the worm, and rub the bore of the barrel and the face of the breech-pin (2,*d*) with it, and immediately put the stopper (33) into the muzzle.

Observe that the breech-pin should never on any account be turned out, except by an experienced armourer, with a proper breech wrench and clamps. Nor should the bayonet-spring (3) ever be unpinned: it may be perfectly cleaned without taking it off, if it be kept well oiled.

The face of the breech pin (2,*d*) may at any time be rubbed bright by means of a piece of cork fixed on to the worm; touch the end of the cork with oil, and then dip it in finely-powdered brick-dust; put the cork down upon the face of the breech-pin, and turn it round and round with the rammer, until the face is bright; then wipe the barrel out clean. If the inside of the barrel is bright and clean, the face of the breech-pin will be seen on looking (in the direction of the light) into the muzzle.

To clean the Lock.

Take every part singly, and wipe it perfectly clean with a moist rag, and then with a dry one; if any part of the interior of the lock should show specks of rust, (which, however, can only arise from great neglect,) put a drop of oil on the spot, and then with the point of a bit of wood oiled and dipped into finely-powdered brick-dust, rub the rust clean out, and wipe the surface dry; then rub every part of the lock, and the inside of the main-spring while it is in the cramp, with a rag that has been slightly oiled,

Digitized by Google

A lock that has been out of use for a long time, or has become gummed and clogged with oil and dirt from any other cause, may be boiled in soap suds, or in water with a little pearl-ash or soda to loosen the thick oil; but heat should never be applied to any part of it in any other way.

To remount the Musquet.

Proceed to put the lock together in the following manner. 1st, If the cock has been taken off, touch the axle of the tumbler (10,*a*) with oil, and put it into its hole in the plate (8,*b*) placing the hook (10,*d*) towards the lower edge of the plate, in the position shown on *Fig.* 7. 2d, Place the cock on the squares of the tumbler (10,*b*), so that the cock-head (9,*c*) shall fall into the hollow for the nipple-seat (6,*d*). Then, with a bit of wood (nothing harder,) tap it home to the axle of the tumbler (10,*a*), holding the tumbler on the inside of the lock-plate, in the hollow of the left hand. 3d, Touch the screw-threads of the tumbler-pin (15,*e*) with oil, and screw it home. 4th, Turn the lock over in the left hand touch the pivot of the tumbler (10,*c*) with oil; put the bridle (11) in its place; in doing this, see that no dirt or grit gets between the bridle and the plate; touch the screw-threads of the bridle-pin (15,*b*) with oil and screw it home. 5th, Place the sear (12) in its place under the bridle; touch the screw-threads and shank of the sear-pin (15,*a*) with oil, pass it carefully through the bridle and the eye of the sear (12,*a*), and screw it home to the shoulder; but not so as to bind the sear. 6th, Put on the sear-spring (13): in doing this, touch the screw-threads of the sear-spring-pin (15,*e*) with oil; pass the pin through the eye of the sear-spring (13,*a*), and turn it into its hole in the plate (8,*f*) two or three threads, until the stud of the spring (13,*b*) bears upon the plate. Then press upon the return of the spring (13,*c*) with the right thumb, until the stud catches into the long stud-hole (8,*l*) in the plate; then screw the pin home. 7th, Put on the main-spring (14): in doing this, take the lock-cramp (31) with the main-spring in it as it was taken off the lock; place the stud of the spring (14,*c*) in its corresponding hole (8,*k*) in the plate, keeping the toe of the main-spring (14,*f*) over the hook of the tumbler (10,*d*), when down at bearer, as in *Fig.* 7. Press the main-spring closely against the plate with the left hand, and with the fore finger of the right hand pull the cock up into the half-bent of the tumbler (10,*e*); then unscrew the fly of the lock-cramp (31,*c*), and take off the cramp; touch the screw-threads of

Digitized by Google

the main-spring-pin (15,*d*) with oil, and screw it home; then clean the outsides of the main-spring, and rub it with the oiled rag. Lastly, touch, 1st, the toe of the main-spring (14,*f*) where it bears upon the hook of the tumbler; 2d, the nose of the sear (12,*c*) where it touches the bents; and 3d, the point of the sear-spring (13,*d*) where it bears upon the sear, with oil, and feel that the parts work smoothly together, by lifting the cock and sear up and down two or three times; then let the cock down upon the bearer.

Observe that the relative lengths of the lock-pins are as shown in *Fig.* 15. The sear-pin (*a*) is the longest, then the bridle-pin (*b*); then the sear-spring pin (*c*); and the main-spring-pin (*d*) is the shortest. And always turn them and all other screws, into their places one or two threads with the finger and thumb, to be certain that they enter fair, before using the turnscrew to screw them home.

In oiling the parts of the lock, bear in mind, that it is not a great quantity of oil that is wanted; it must be good clean sweet or olive oil, (linseed oil must on no account be used to any part of the lock,) and put only the smallest drop with the end of a shaving or feather on the parts, before described, that rub.

To replace the Barrel.

1st. Draw out the three bolts gently as far as they will come, in the manner described at page 357. 2d, Drop the barrel into its place in the stock, and squeeze it down with a grasp of the hand, while you give the butt of the stock (17,*a*) a gentle tap against the floor to settle the breech end of the barrel (1,*a*) close up against the head of the stock (17.*c*). 3d, Touch the screw-threads of the breech-nail (30,*a*) with oil, put it into its place and screw it nearly home, but not quite. 4th, Squeeze the barrel and stock together with a grasp of the hand, and press in the hind-bolt first (28,*a*), the middle bolt (*b*) second, and the front-bolt (*c*) last; press them home with the inside of the hand, or a bit of wood against the head; but be careful to press them in a straight direction, so as not to splinter the wood of the shaft. 5th, Put on the shaft-swivel (26): to do this, touch the screw-threads of the pin (26,*b*) with oil, put the swivel in its place (the head being on the same side of the shaft as the heads of the bolts;) pass the pin through the shaft, and enter it two or three threads in the opposite eye of the swivel by hand, and then screw the pin home with the turnscrew, but so as to permit the swivel to play freely.

Digitized by Google

To replace the Lock.

1st. Pull the cock up to the half-bent of the tumbler (10,*e*). 2d, Take the lock in the right hand, with the arm of the sear (12,*d*) towards you, holding the stock with the left hand by the swell (17,*d*), with the butt (*a*) between the knees ; then, with the back of the little finger of the right hand behind the trigger (20,*c*), press it forward, so that the arm of the sear may enter clear, and, with the same hand, put the lock into its bed in the stock, pressing the plate well down into the wood. 3d, Turn the musquet over, holding the lock and stock together with the left hand, and with the right, put in the side-nails (30,*bb*), after having touched their screw-threads with oil, and turn them nearly home. Then screw the breech-nail of the barrel firmly home, and now draw the lock hard up against the barrel, by turning the hind side-nail home first, and lastly the front side-nail ; and be sure that these nails are drawn quite home, but not forced ; because, otherwise, the mouth of the cock-head (9,*e*) will not stand centrally over the cone of the nipple (4,*a*).

N. B.—It is essential that the musquet should be put together in the course here pointed out, and not in any other.

Clean the rammer, and rub it bright with a leather and fine brick-dust or rotten-stone, taking care not to wear away the screw-threads on the end of the rod.

Clean and polish the bayonet, rubbing it quite dry with the leather and rotten-stone.

Clean and furbish the brass-work by means of rotten-stone moistened and laid on to it, and then rubbed bright with a bit of soft leather ; and, in doing this, take care that no dirt gets in to the mortice of the trigger-plate (19,*d*), because this will stop the free play of the trigger, and cause the gun to go off at half-cock.

Lastly, rub the wood of the stock all over with linseed-oil ; (sweet or olive-oil will not do, because it will not dry ;) let it stand for two or three hours when there is time, and then rub it with a woollen rag, covered with linen, until the wood is perfectly dry ;—if this be repeated from time to time it will produce a polish that no wet will disturb.

Buckle on the sling when it is perfectly dry, for, after being pipe-clayed, if it be not made quite dry, it will rust the swivels, and spoil both the swivels and the sling itself.

Digitized by Google

Return the rammer to its place.
Fix the bayonet.

If, by any accident, the muzzle of the barrel should be bent or bruised; the socket or neck of the bayonet or the cock-head bent by a blow; the trigger become bound in the wood; the nipple or turnscrew broken or battered; or any part of the arm damaged in such a manner as to require the use of a file, a tool, or a hammer, to adjust the parts; the work should not, on any account, be attempted by the soldier himself: it should be brought to notice in the proper course, in order that the repairs may be executed by an experienced armourer, and by him only.

It is not at all times necessary to take the musquet to pieces to clean it; for after firing in fine weather, or when there is no chance of wet having got in between the barrel and the stock, the arm may be perfectly cleaned in the following manner:—

Put a piece of rag or soft leather on the top of the nipple, and let the cock-head down upon it; pour about a gill of water into the muzzle of the barrel carefully, so that it does not run down the outside; put the plug of wood into the muzzle and shake the water up and down; pour this out, and put fresh water in until it comes out clear; then pull the cock up to the half-bent; take the cover off the nipple, and put the musquet with the muzzle downwards on a piece of board or a wooden floor to drain for a few minutes, and then wipe out the barrel dry, as before directed at page 359 and wipe all the exterior of the lock, and the outside of the breech end of the barrel round the nipple and nipple-seat, first with a damp rag, and then with a dry one, and lastly with a rag that has been slightly oiled.

In this way, the evil of taking out screws and drawing bolts, which always tends to wear and loosen them, may often be avoided; and if a little soft bees'-wax be rubbed into any cracks or openings that may show round the lock or the sides of the barrel, from the wood shrinking by the effects of time and weather, the musquet, in the hands of a careful man, will very seldom need to be dismounted.

But whenever the cock is observed to work stiff, or feels rough or grating upon the tumbler in pulling it up, the lock should be immediately taken off, and the parts cleaned or touched with oil, as before directed.

Digitized by Google

Observe, that much more rust is produced by percussion caps exploded on the nipple, when no charge is in the barrel, than when gunpowder is fired by them. Therefore, the greater care ought to be taken in cleaning and oiling the arm, if ever such a circumstance should happen.

THE PERCUSSION MUSQUET OF THE REGIMENTS OF FOOT GUARDS.

Differs in no essential point from the musquet of the Line, except in the fitting of the breech of the barrel, and in the arrangement of the parts of the lock.

Fig. 35.—The hutt of the barrel, half size—*a*, the hook; *b*, the screw-threads; *c*, the face.

Fig. 36.—The break-off, two ways, half size—*a*, the tang; *b*, the head; *c*, the square; *d*, the break-off-nail. These, with the hutt, serve the purpose of the breech-pin (2) of the musquet of the Line.

Fig. 37.—The back-action lock. This has all the parts of the side-lock (7), but in different positions; the movement of the main-spring is reversed; the sear-spring is held by a pivot through the plate, instead of a pin; and the bridle by two pins, instead of one pin and a stud; the lock is secured by one side-nail and by a hook in the tail of the plate slipping under a flat-headed wood screw; which screw is never on any account to be disturbed.

A, the plate; *b*, the nib; *c*, the stop for the main-spring; *d*, the side-nail hole; *e*, the tail of the lock-plate; *f*, the hook; *g*, the cock; *h*, the tumbler; *i*, the bridle; *k*, the sear; *l*, the main-spring; *m*, the sear-spring; *n*, the two bridle-pins; *o*, the sear-pin; *p*, the flat-headed wood-screw in the hand of the stock, which holds down the tail of the lock-plate.

Fig. 38.—The tumbler of the back-action lock, half size-*c*, the pivot; *d*, the hook; *e*, the half-bent; *f*, the whole bent; *g*, the bearer.

Fig. 39.—The sear-spring of the back-action lock, two ways, half-size—*a*, the pivot; *b*, the stud; *c*, the return; *d*, the spring.

To dismount the back-action Musquet.

Proceed with the first eight movements in the same manner as described for the Line Musquet, at page 357, but the

Digitized by Google

breech-nail is not at any time to be disturbed—9th. Take out the barrel by lifting up the muzzle, which will unhook it from the square of the break-off (36,*c*). 10th, Unscrew the side-nail ; and, 11th, Take off the lock : in doing this, turn the musquet with the lock downwards, and the lock will fall out into the left hand, by a few taps with the right hand upon the side of the stock head (17,*c*.

To dismount the back-action Lock.

1st 2nd, and 3rd, Take off the main-spring with the lock-cramp (31) in the manner described at page 358, (observing that there is no main-spring-pin in this lock,) and when the spring is detached from the plate, leave it in the cramp. 4th, Relieve the sear (37,*k*) from the spring (*m*) ; to do this, hold the lock, cock downwards, in the left hand with the tail of the plate (*e*) towards the wrist ; slip the lever of the sear-spring-cramp (34,*b*) with its point endways, between the sear and the sear-spring, until the hook (*c*) of the bar (*a*) falls over the pivot of the spring (39,*a*) underneath the bridle (37,*i*) ; keep the lever down flat upon the plate with the left thumb, and screw up the fly of the cramp (34,*d*) until the pressure of the spring is just taken off the sear, which may be known by feeling if it shakes ; then unscrew the sear-pin with the small limb of the turnscrew (32,*e*) and take it out, and the sear. 6th, Unscrew the two bridle-pins (37,*n*), and take off the bridle (*i*). 7th, Take off the sear-spring (*m*), and leave it in the sear-spring-cramp ; and then proceed according to the instructions and remarks for the common side-lock in page 358.

In cleaning the back-action musquet, the same instructions should be followed precisely as are given in the 359th and following page ; taking especial care not to bruise or batter the hook of the hutt (35,*a*) or the nipple-seat of the barrel, because this would prevent them fitting into their places again.

To remount the back-action Musquet.

1st, Draw out the bolts as directed at page 357 2nd, Place the hook of the hutt (35,*a*) carefully into the square of the break-off (36,*c*) holding the barrel in a slanting direction until it enters easily ; when it is entered fair, press the barrel down into its bed, but not forcibly, for, if it requires force, there must be dirt in the square of the break off, or else the hutt must have been battered ; in either case, the stock will

be broken if the barrel be *forced* down ; it should therefore be taken out again, and the square cleared, or the barrel taken to the armourer, whichever may be required. When the barrel is down, squeeze it close to the stock and press the bolts home, and put on the shaft-swivel in the order and manner described at page 362.

Put the lock together as regards, 1st, the tumbler, 2d, the cock, and 3rd, the tumbler pin in the course pointed out at page 361 ; that is to say, if the cock has been taken off, which, however, should very seldom be done, for the reasons already stated, page 359. 4th, Turn the lock over in the left hand ; touch the pivot of the sear-spring- (39,*a*) with oil and put the spring into its place on the plate. leaving the sear spring-cramp on it. 5th, Touch the pivot of the tumbler (38,*c*) with oil, and put the bridle (37,*i*) in its place ; touch the screw-threads of the two bridle-pins (*n*) with oil, and enter them in their corresponding holes with the finger and thumb ; then screw them home with the small limb of the turn-screw (32,*e*). 6th, Put the sear in its place ; touch the screw-threads of the sear-pin with oil : pass it through the bridle and the eye of the sear, and enter it one or two threads into the plate ; then screw it home, but not so as to bind the sear. 7th, Now unscrew the fly of the sear-spring-cramp (34,*d*), and take it off. 8th, Put on the main-spring, and proceed with the lock in the manner described at page 361.

Put on the Lock.

In doing this, turn the musquet sideways with the left hand, and put the lock into its bed in the way directed at page 363, observing to first slip the hook in the tail of the lock-plate (37,*f*) under the flat-head of the wood screw (*p*), and then press the nib (*b*) fair into its place ; turn the musquet over, holding the lock in its place with the left hand ; touch the screw-threads of the side-nail with oil, and screw it firmly home with the broad limb of the turn screw (32,*b*), taking care not to gall the head of the stock with the small limb in turning it round, or by letting it slip out of the slit in the nail-head.

Then complete the remounting of the arm in the course pointed out for the musquet of the Line.

THE PERCUSSION CARBINE OF THE CAVALRY.

Is constructed upon the same principle as the musquet of the Foot-Guards, with back-action lock and break off ; except that it is smaller in all its parts, and has

Digitized by Google

Fig. 40.—The scroll-handle or guard, one-fourth size—This gives the trooper a more firm hold when presenting with one hand—*a*, the scroll; *b*, the bow; *c*, *c*, wood-screws; *d*, break-off-nail.

Fig. 41.—The side-rib and ring by which the arm is slung when the trooper is mounted, one-third size—*a*, the rib; *b*, the ring; *c*, the pin; *d*, the rib-nail.

Fig. 42.—The swivel for connecting the rammer to the barrel, to prevent its being dropped, half size—*a*, the swivel; *b*, the pin; *c*, the rammer-head.

With reference to this fitment, it may be useful to observe here, that in "examine arms," the rammer of the carbine should not be thrown down with violence, to make it tell upon the breech-pin; for, if it be, the end of the rammer will be battered and shortened; and the swivel coming to bear upon the muzzle of the barrel, the latter will be defaced, and the swivel broken; for all purposes of seeing whether the barrel is clean, it is sufficient if the rammer be let fall with its own weight only a distance of two or three inches.

The Cavalry carbine is dismounted, cleaned, and remounted, in the manner and course before described for the musquet of the Guards, and that of the Line; except that, in wiping out the barrel, the swivel-pin (42,*b*) must be taken out, before the rammer can be used, unless an extra washing-rod should be at hand.

THE PERCUSSION INFANTRY RIFLE.

Is also constructed like the back-action musquet of the Foot-Guards; and, in addition to the parts common to that arm, it has a scroll-handle or guard of the same kind as that of the Cavalry carbine; a trap in the butt; a sword-bayonet fitted to a bar on the barrel, and an elevating back-sight.

Fig. 43. The trap for containing the implements and greased patches—*a*, the plate; *b*, the joint; *c*, the trap-spring; *d*, the wood-screw; *e*, the button in the trap for holding in the jagg and ball-drawer.

Fig. 44.—The sword-bayonet, one fifth size, which is fixed on to a bar on the barrel; *a*, the grip; *b*, the groove for the bar; *c*, the cross-guard; *d*, the blade; *e*, the press-pin (45,*d*) of the spring.

Digitized by Google

Fig. 45.—The sword spring, half-size ; *a*, the spring ; *b*, the pin ; *c*, the catch ; *d*, the press-pin.

Fig. 46.—The back-sight, three ways, half size—*a*, the sight with the leaf (*c*) down ; *b*, the block-sight, for 200 yards, distance ; *c*, the leaf-sight, elevated for 300 yards distance.

Fig. 47.—The jagg for wiping out the barrel ; and Fig. 48, the ball-drawer, half size ; in using them , pass the lever on the wrench (32,*c*) through the hole that is under the head of the rifle-rammer, and then screw the implement in to the brass-cased tip of it ; and this lever will also give power to force the bull-drawer into the ball when required by screwing, and serve as a hold to draw it out by gently, without rubbing the inside of the barrel ; and to avoid this it is that the rammer is tipped with brass.

In dismounting, in cleaning, and in remounting the Infantry rifle, the same course is to be followed as before directed for the musquets of the Line of the Foot Guards.

The barrel is rifled with two opposite grooves, which make one whole turn like a screw round the inside of it in its length of thirty inches ; these grooves are intended, in loading, to receive the two sides of the belt on the ball, which, as it passes down upon the powder, takes very nearly one turn round its centre ; and, of course, in passing rapidly out again from the effects of the charge, acquires a spinning motion round its centre, which keeps it more steady to the aim than balls fired from plain barrels.

The ball is always enveloped in a greased patch, to prevent the lead from rubbing off against the iron of the barrel ; and it is most essential to accurate shooting, that the bore and grooves of the barrel should be kept perfectly bright and clean, otherwise, if they be allowed to get the least rusty or rough, the patch sticks to the inside of the barrel, the ball slips out of it, and the naked surface of the ball coming in contact with the barrel, the belt is liable to be stripped off, and the proper accurate effect of the rifling is destroyed. Therefore, after cleaning the barrel, the greatest care should be taken to wipe the inside of it most perfectly dry with a rag round the jagg (47) ; and to keep it always greased with a bit of fresh mutton-suet ; with a stopper in the muzzle and with a piece of rag or soft leather between the nipple and the cock head, which should be left down.

Digitized by Google

But, besides all the precautions in dismounting, remounting, and cleaning, which have been pointed out in the foregoing pages, habitual care in handling the arms will tend more than any thing to keep them in good and serviceable condition.

For instance, in sudden rain on a march, the musquet being carried with the muzzle and lock downwards, and the lock under the arm, or protected by the great coat, when worn, the wet will run off at the muzzle, and not get down towards the lock. In ordering arms on parade exercise, if the butt be brought down gently upon the ground, the mechanism of the lock will be saved from that shock which is so very injurious to it, and to every part of the musquet when it is dropped hard; more especially when the exercise takes place on stone pavement or a hard road: all needless thumping and rattling the arms, merely to make the motion "tell," also tends much to loosen the bolts and pins.

Care in piling arms, so that the firelocks may not get unlocked from each other and fall to the ground; placing the firelock carefully in the arm-racks when relieved from guard, so that one may not be knocked against by another, or bruised by coming in contact with tables, benches, &c.; never leaning the naked muzzle of the barrel against the floor or ground while cleaning or wiping the firelock; but always keeping the stopper or plug of wood in its place. In these, and various other circumstances, the soldier, by a careful course of this kind, will manifest that he takes a pride in his arms; and, although he may have to carry them in peaceful parade for many years yet, whenever the sudden moment shall arrive that he is called upon to use them against the enemies of his country, he will then find the benefit of this continued care, and feel no fear or failure when he receives the word to Fire.

Digitized by Google

DIRECTIONS PROPER TO BE OBSERVED IN USING PERCUSSION ARMS.

1st. Muskets with percussion locks require to be carefully handled, to prevent the cocks being made loose, by which their direct fall on the nipples would be rendered uncertain.

2nd. They will at all times, when unloaded, be used with the cocks down upon the nipples; but when they are loaded, the caps or primers will be put on, and the musquets carried at half cock for safety, there being then less risk of accidental explosion than with the cocks resting on the caps.

3rd. When marching, when the cap is on, the cock will be brought up under the arm-pit, the sling resting on the arm; but at other times the firelock may be carried with the barrel downwards, the right hand grasping the piece between the loop and swell, and the left, the right arm just below the elbow.

4th. Load with the cock down, which prevents the powder from being forced out of the nipple that receives the copper caps.

5th. Prime the last thing; otherwise in ramming down the wadding, the powder will be driven into the caps and become so firmly compressed as to destroy their effect.

6th. Should the caps be put on by mistake, prior to loading, force them off with the turn-screw, and replace them with new ones.

7th. When the recruit has attained a perfect knowledge of the Platoon Exercise he is to be carefully habituated in *taking aim*: to this great object too much care and attention cannot be devoted; it is the means by which the soldier is taught to fire with precision, or in other words *to kill his enemy*; and it cannot be too strongly inculcated, that every man, who has no defect in his eyes may be made a good shot at a fixed object. The firelock is placed in the soldiers hands for the destruction of his enemy, his own safety depends on his efficient use of it, and no degree of perfection he may have attained in the other parts of his drill, can, upon service, remedy any want of proficiency in this; indeed all his other instruction in marching and manœuvring with perfect steadiness and precision, can do

Digitized by Google

no more than place him in the best possible situation for using his weapons with effect. The true principles upon which correct shooting may be taught are extremely simple: they are to be found in the natural connection that exists between the hand and the eye: the eye is the guide and regulator of every action of the hand, which can only act the part of a subordinate agent; and constant practice must therefore be employed to perfect the connection and enable them so to act together, that the hand will readily raise the firelock in a line with any object that the eye is fixed upon. In training the recruit to the use of his musquet, the following instructions are to be carefully attended to.

8th. The recruit is next practised in aiming at an object: He is taught to fix his eye steadfastly on the bull's eye, or any other object, and with the left eye shut, to raise his firelock gradually and horizontally from the priming position, until it is accurately aligned.

9th. The centre part of a man, at 180 paces, is perhaps the best general rule to lay down for aim.

10th. It is most important that soldiers should be accustomed to judge of distances correctly; that they should know how far their firelocks will carry point-blank, and also the exact degree of elevation that is required in order to hit objects at different distances beyond the point-blank range. They should, therefore, be trained to a knowledge of distances on every kind of ground, and be at all times prepared to answer correctly the following simple questions.

1st. What is the point-blank range of your firelock, or rifle?

2nd. Does it carry to the right or left?

3rd. How many paces distant are you from such an object?

4th. What is the requisite degree of elevation in order to enable you to hit the body of a man at 120, 150, 200, &c. paces?

11th. In making ready after the first fire, as soon as the piece is half cocked, the fore finger of the right hand is to be raised, and the old cap displaced with it, then put on a new cap.

Artillery-Depôt,
1842.

Digitized by Google

Digitized by Google

Miscel
Sm

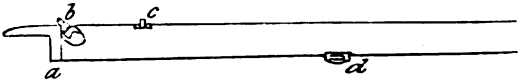
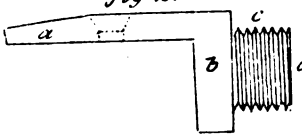


fig: 2.



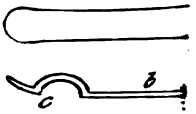


fig: 6.

fig: 8.

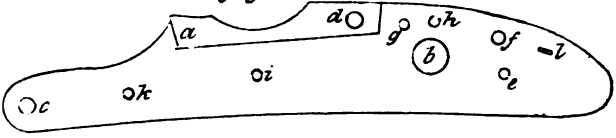


fig: 12.

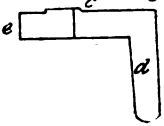
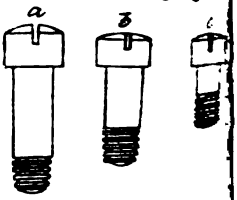






fig.



Art^y Depôt Lith^y

Digitized by Google

neous.

Arms.

Plate 42.

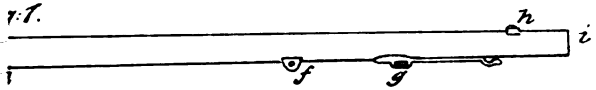


fig: 4.

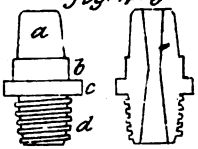


fig: 5.



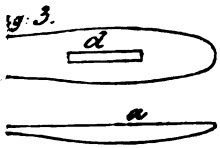


fig: 7.



fig: 10.

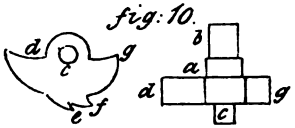


fig: 11.

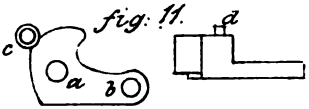
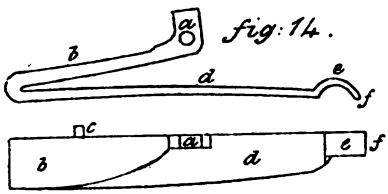
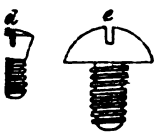




fig: 14.





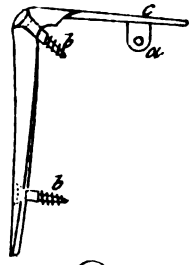
E. P. C.

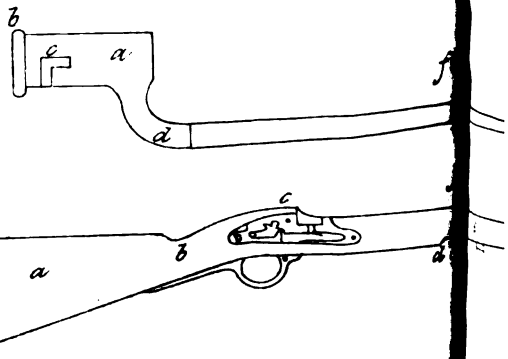
Digitized by Google

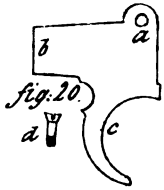
Digitized by Google

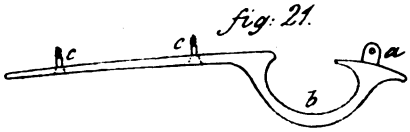
Digitized by Google

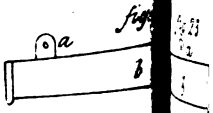
Miscella
Small

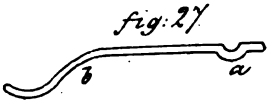


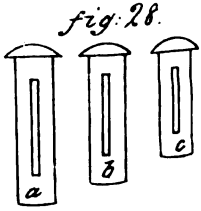


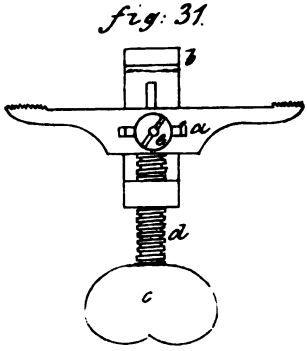














Art.y Depôt lith.e

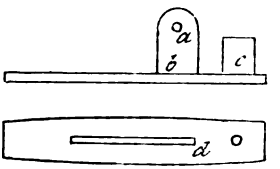
Digitized by Google

us.

ns.

Plate 43.

fig: 19.



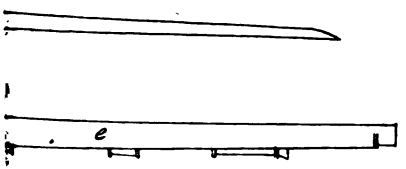


fig: 23.

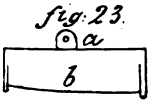


fig: 24.

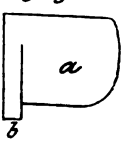


fig: 25

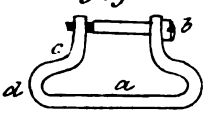


fig: 26.

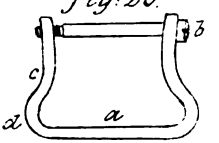
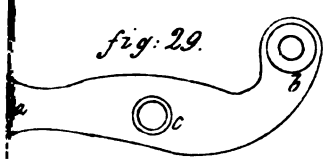


fig: 29.



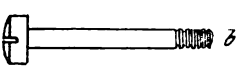
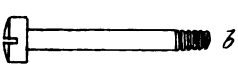


fig30



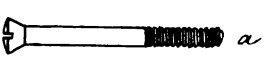


fig. 33.

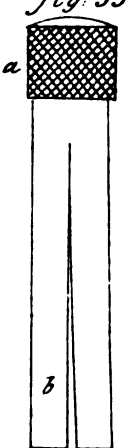
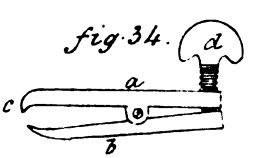


fig. 34.

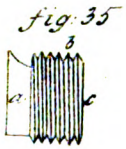


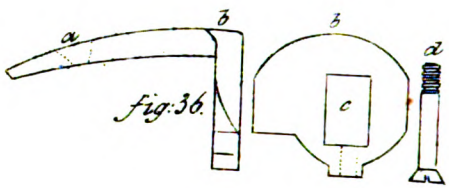
Digitized by Google

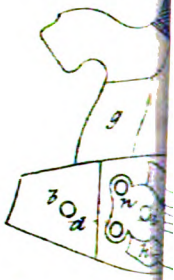
Digitized by Google

Digitized by Google

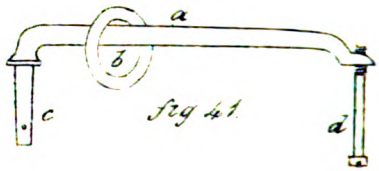
Miscel
Sma

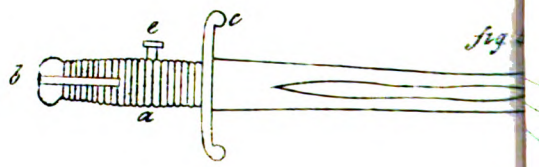


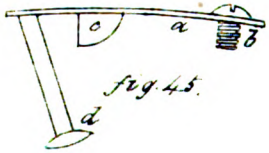


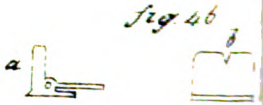






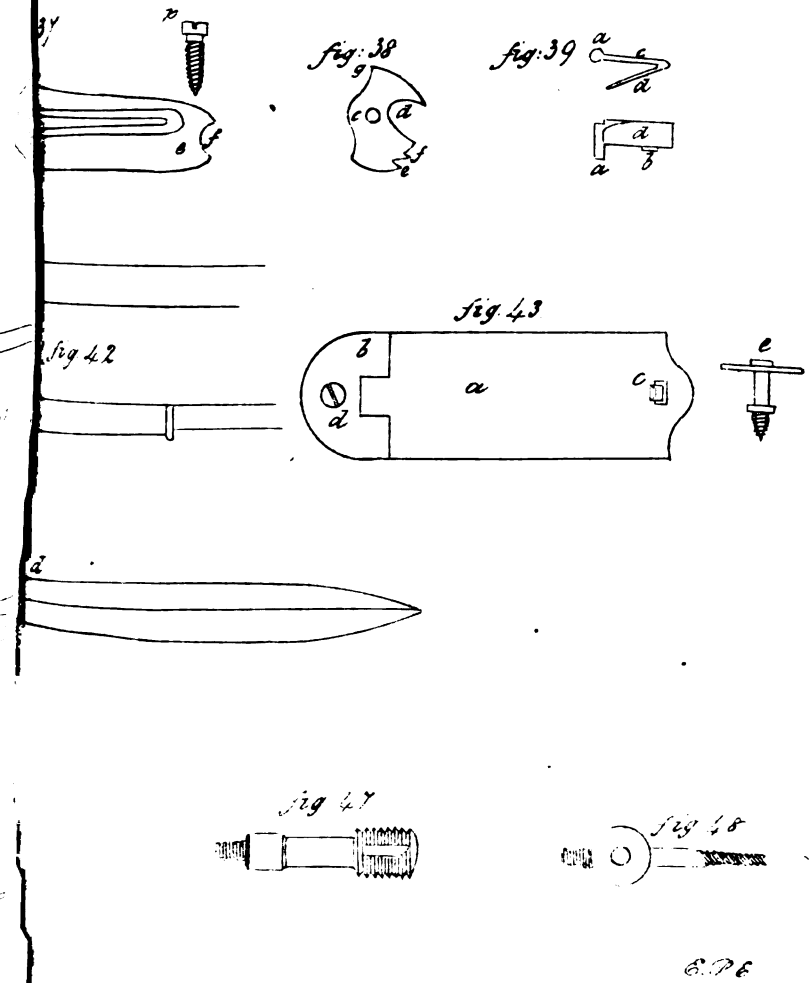






Artillery Depot lith.

Digitized by Google


fig: 38
fig: 39
fig 42
fig 43
fig 47
fig 48

Digitized by Google

MEMORANDUM OF DISMANTLING THE FORT OF GUDJUNDAGHUR, BY LIEUT. H. BELL, OF THE BOMBAY ENGINEERS, JULY 1842.

Plate 45, 46, 47, 48,

Lying 70 miles *N. E.* from Dharwar is a Fort constructed on the extremity of a spur of rocky hill about a mile and a half in length running out in a westerly direction from the main range. The Fort itself is about 1000 yards long, and 450 in average breadth, and its height above the surrounding country may be calculated at about 360 feet. It contains a tank of good water, and is in excellent order, on the north side from C to D, the rock is perpendicular to the height of from 100 to 150 feet, and the defences consist of a simple loop holed wall ; averaging 6 feet in height with bastions at long intervals of no strength,—on the *S.* and *S. E.* points viz. from H to A the rock is also generally precipitous, the works however are of better construction, the stonework being enormous, particularly in the front N A, overlooking the town. Bastions L and N, are the largest in the Fort, and capable each of mounting from 5 to 8 guns. M, is an old gateway, sometime blocked up, there are signs here of rude steps cut in the rock, and leading down the hill. In the front N A, near bastion A, is an excellently flanked double gateway, leading down to the town by a flight of 220 steps.

The west front from D to H, consists of a double line of works, of which the outer is very strong, and high, however, as the rock at this point is of no great height, and a spur of hill runs out nearly on a level with the works, to the westward, on which, batteries to breach the front could easily be constructed, this may be considered the weak point in the Fort. A gateway at E, in interior line leads to outer works.

The north east side of this Fort, being that which is naturally the weakest, from the commanding height of the ground, near the junction of the spur with the main hill, from whence the Fort is seen as far as its centre, has been strengthened by a treble line of works, of which the interior A, B, C, is particularly high and strong, and still further, to remove the danger of an attack on this quarter the rising knolls x, x, x, have been enclosed by a line of works O, P, Q, R, thrown across the hill, about 800 yards in advance of A, B, C. This latter work is of inferior construction, consisting of loose stone work, with the exception of bastions, O, P, Q, R, which are strong and well built. The communication to this line is by a strong single gateway, in line A, B, C, and a subterraneous large gallery through the outer works. See *Plates* 49, 50.

Google

A small citadel of about 50 yards square, is inside the Fort, and there are remains of defences, in an unfinished state, as also many unfinished buildings.

In order to render this place untenable by any body of men, it was determined to entirely destroy the works on the *N. E*, and *W.* sides of the Fort, viz. the lines, O, P, Q R, A, B, C, and D, E, F, G, H, I, J, K, to remove the interior gate of the entrance near A, from the Pettah, and the *S. E.* bastion, and adjacent curtains of little citadel, and to demolish the bastions L, and N, and the old gateway M, with its defences.

By these means the only accessible points of attack would be cleared of their defences, and all works capable of mounting ordnance, rendered useless.

This plan of operations has been acted upon, and the accompanying detailed plans will explain the mining operations, employed to effect the demolition required, but as bastion N, the exterior gate of the entrance near bastion A, and the south east tower and adjacent curtains of the citadel, do not appear in those detailed plans ; it must be understood that those works were removed, by picking down without the aid of mines.

North East Front. *Plates* 49, 50.

The interior line of works in this front, consisting of bastions A, B, C, and their connecting curtains is the highest, strongest, and best built, in the whole Fort. The bastions, (with the exception of bastion C, which is unfinished,) are capable of mounting heavy ordnance, and the curtains have terrepleins from 15 to 18 feet in breadth, and are from 35 to 40 feet in height exteriorly. This whole line is composed of stones varying from 5 to 12 tons in weight, most closely fitted and cemented, and the gateway between bastions B, and C, facing to the north west, is very strong, above it is a small room.

At about 100 feet in front of this line is an immense body of earth, about 110 feet in width raised by art, and supported interiorly by a wall, varying from 25 to 30 feet in height, and exteriorly, by an escarp of from 20 to 25. The sides of this mass are supported by strong walls, rising above the precipitous rock. It is sloped to the front like a steep glacis. Above the inner wall is a terreplein of from 18 to 20 feet wide similar to a covered way, and the escarp is raised so as to form a species of corridor for musketry. The ditch in front of this escarp is from 50 to 60 feet wide, and mostly blasted out of the rock. A subterraneous arched passage, 14 feet wide, but varying in height, winds through this work, forming a communication between inner and

Digitized by Google

outer ditches. It has a strong door at either end. This earthen work is connected with the line A, B, C, on the town side by a strong stone rampart and parapet (*Plate* 50, *Fig.* 7.) and on opposite side by an insignificant wall (*Plate* 50 *Fig.* 6.) The masonry of the escarp and exterior counterscarp of this work, is of similar strength to that of the line A, B, C, plate 49, as also that of flank supporting walls. But the interior revetment, and the subterraneous passage are of inferior stone work, though excellently built.

The plan and sections will illustrate the arrangement of the mines, for the demolition of this front and their effect, with the appearance of the front at the completion of the operation, may be seen in the sections *Plate* 50.

WEST FRONT. *Plates* 51, 52.

The two lines of works composing this front have been built at different periods of time, the outer being evidently of much later construction.

In the exterior line the 3 bastions are of great strength, particularly bastion I which is very large, in the centre of this bastion is a small subterraneous Hindoo temple, the entrance to which, is by a strong stone gallery 8 feet 5, pierced through the inner revetment of the bastion. Bastion J is in an unfinished state having been only partially filled in. The stonework of these three bastions, though not so highly finished as that of bastions A, B, C, *Plate* 49, in the N. E. front is equally vast, each stone weighing at least 6 tons. The lines of rampart connecting these bastions, are of excellent construction, and well cemented, these are, however, in some places not completely finished viz. at *x*, *x*, *x*, *x*, and at others though finished, of a weak profile as at *y*, *y*, *y*, *y*. The masonry of these lines is not similar to that of the bastions.

In the interior line, bastions D and H, as well as bastion E, and the square tower, covering the gate, are the only works that are of stone cemented. Bastion D is the highest in this front, and very commanding, but it is unfinished in rear. This bastion and bastion H, only, can mount heavy ordnance. The remaining bastions F, and G, and the curtains along the whole line are of stone uncemented but of excellent construction, with the exception of the line between bastion F, and the gate, which has bulged throughout, and probably given way at one time, as there are signs of recent repairs. The wall is highest here, being above 30 feet. The gateway at E, is of highly finished stonework and in excellent order.

The arrangement of the mines, for the entire demolition of both of these lines, may be seen in the plan of the front,

and the sections, *plate* 52, will show the effects of those mines, and the present state of the works which compose the front.

GATEWAY AT M.—*Plate* 53, A.

The works of this gateway have been arranged according to the form of the curious nature of rock at this point. They are in some places unfinished. The masonry is cemented throughout, but not large. Opposite to the blocked up gate, is an arched room, also blocked up, having no entrance to it, except from outside the Fort.

The arrangement of the mines will be shewn by the plan, and their effect by the adjoining sections, the whole work except the gate, has been levelled.

BASTION L.—*Plate* 53, B.

This bastion, the largest in the Fort, is paved with stone, and of excellent construction, the stonework enormous. The effect of the 5 mines employed in its demolition, (see plan) have been to reduce it to the appearance shewn in the adjoining sections, rendering it perfectly useless.

BASTIONS O, AND P. *(N. W. Front.) Plate* 53, C.

Bastion O, is a firm, well built work, capable of mounting a heavy gun, and its masonry, though not large, is very strong, and well cemented.

Bastion P, is very large, well built, and commanding ; it can mount 5 guns. It consists of an artificial mound of earth, having sides with an angle of 45°, on the summit of which the stonework bastion is constructed, the masonry is good. An arched chamber under the terreplein of the bastion, is reached by descending a flight of stone steps. The entrance to the bastion is by the curtain, connecting it with bastion O. This curtain is of strong profile (see section) and slopes like a ramp, up from bastion O. The interior supporting wall of the double ramp, both at *z* and *x*, is of uncemented, though strong masonry.

The method of destroying these two bastions by mining may be seen in the plan, and their present state, in the adjoining sections.

N. B.—Bastion Q, which is nearly similar to bastion P, was not destroyed by mining, but, with bastion R, and the rest of the works forming this advanced line, *Plate* 48, was picked down to the same section nearly as shown in C plate 53.

The connecting curtain between O and P was also picked down, (see section plate 53, C.)

Digitized by Google



dras Art y

Digitized by Google

Digitized by Google



Digitized by Google

Digitized by Google

Plate 47



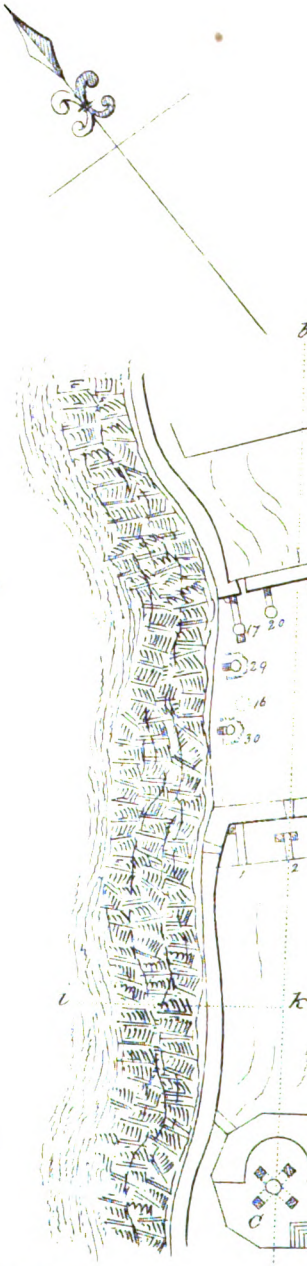
Digitized by Google

Digitized by Google


Plate 48.
Main Hill
O
P
Gate
Q
x
to Hydrabad.
Evans
1500 yards

Digitized by Google

Digitized by Google

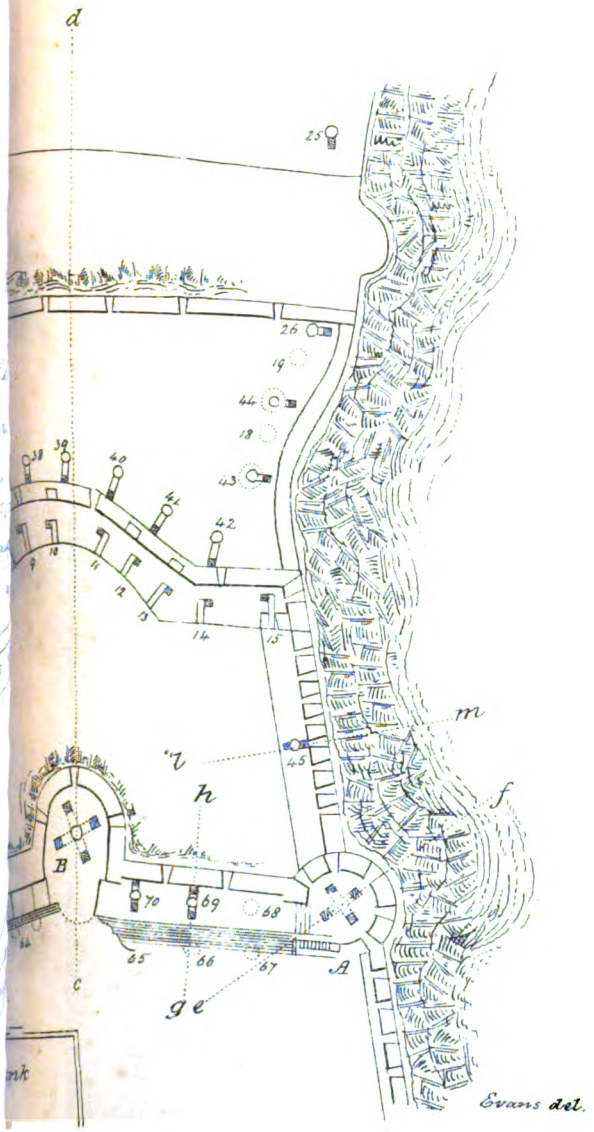


Artil.y Depot lith.r

Digitized by Google

feet 100 50

Plate 49.



200 300 feet

Digitized by Google

Digitized by Google

Sections (Plate 49)

Plate 50.

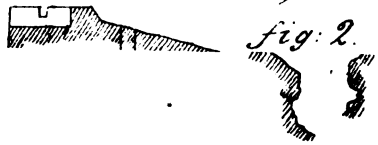
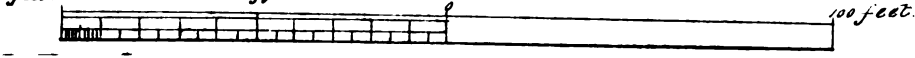


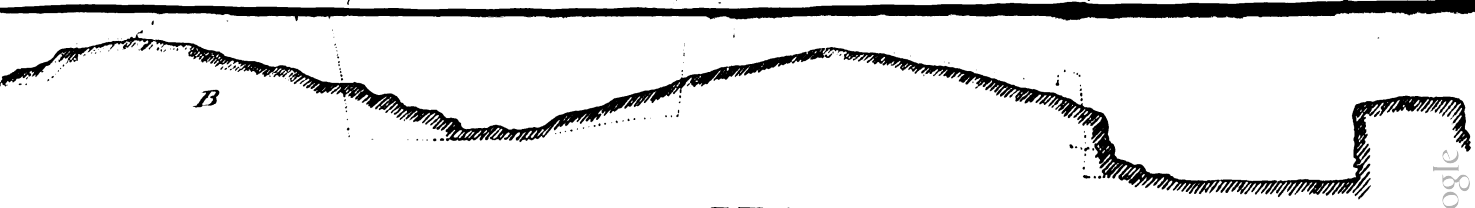
fig: 2.

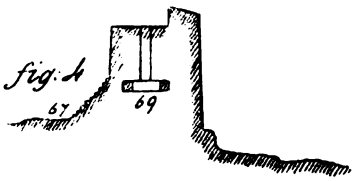


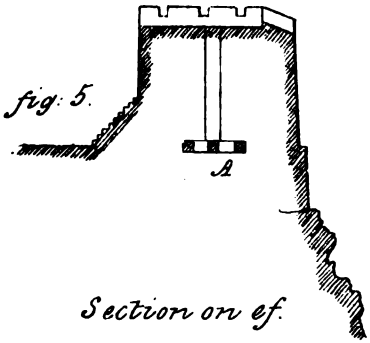


Art.y Depot lith.a

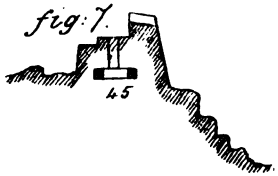
Digitized by Google









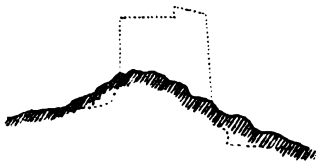


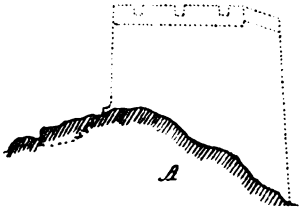
Section on gh

Section on ef.

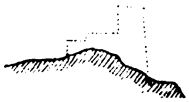
Section on ik.

Section on lm.







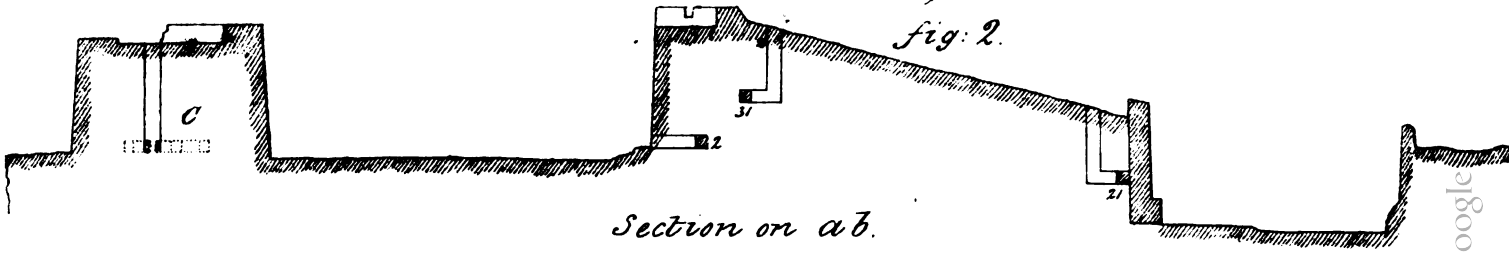


Digitized by Google

Sections (Plate 49)

Plate 50.

fig: 2.



Section on a b.

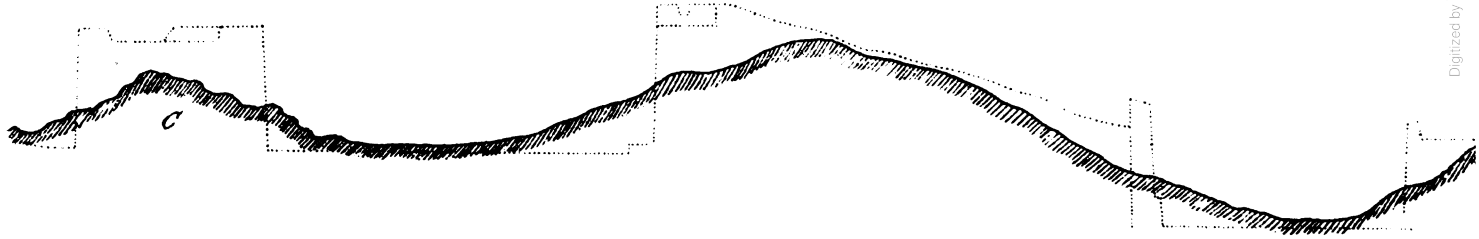
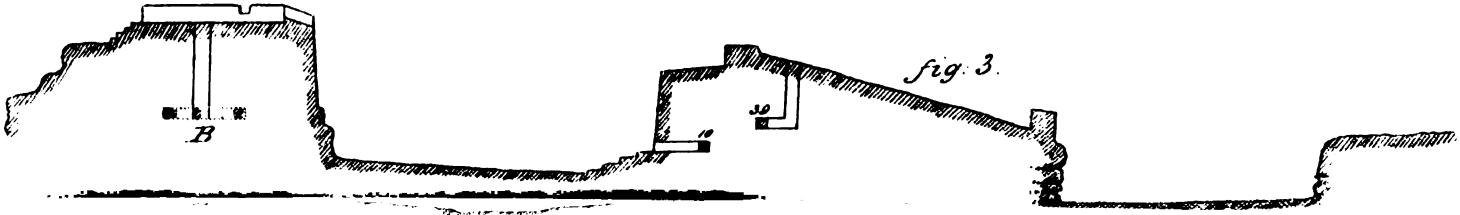


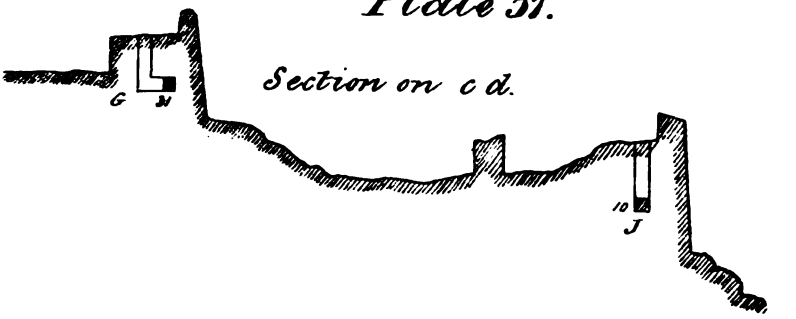
fig: 3.

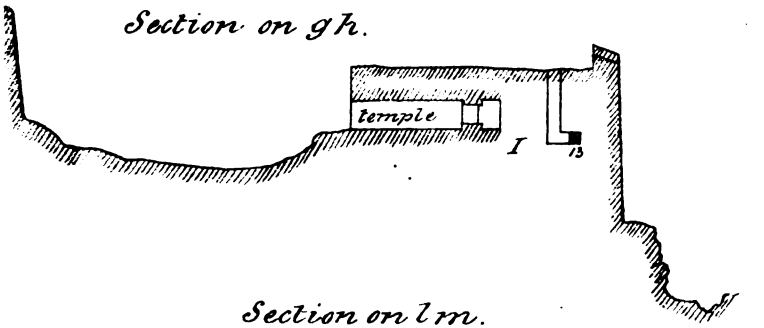


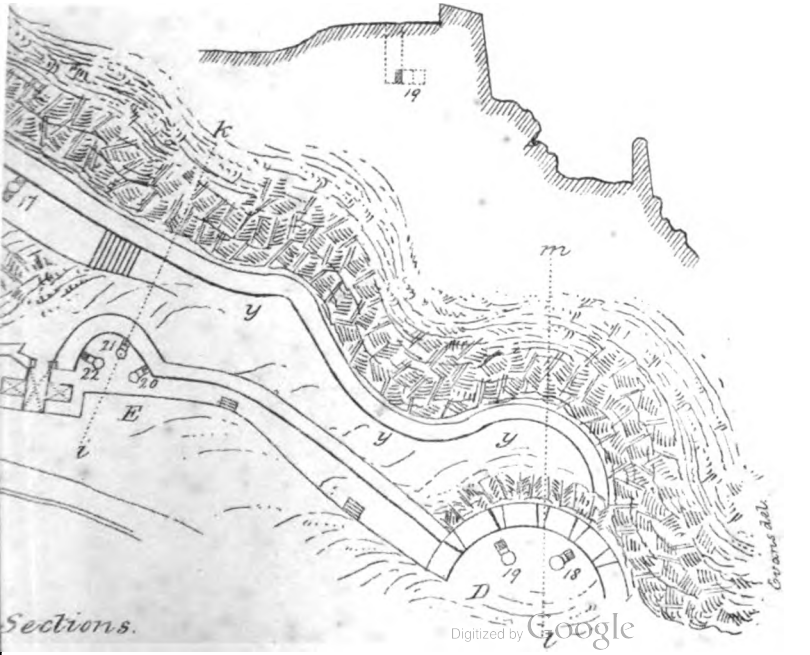
Digitized by Google

Digitized by Google

Plate 51.







Digitized by Google

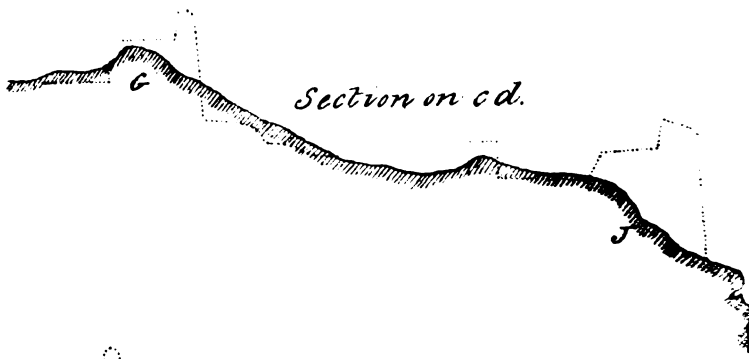
Digitized by Google

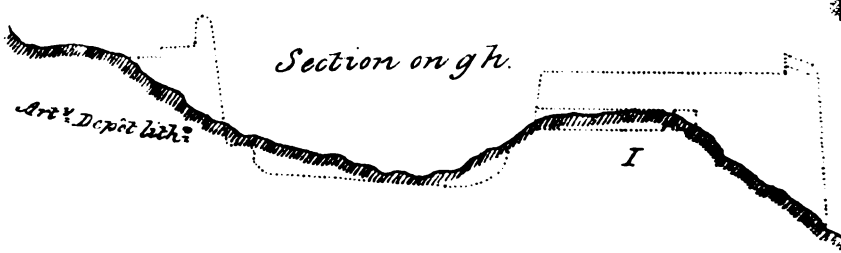
Digitized by Google
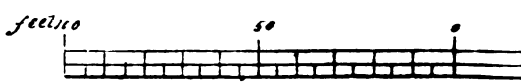
Miscella

Sections

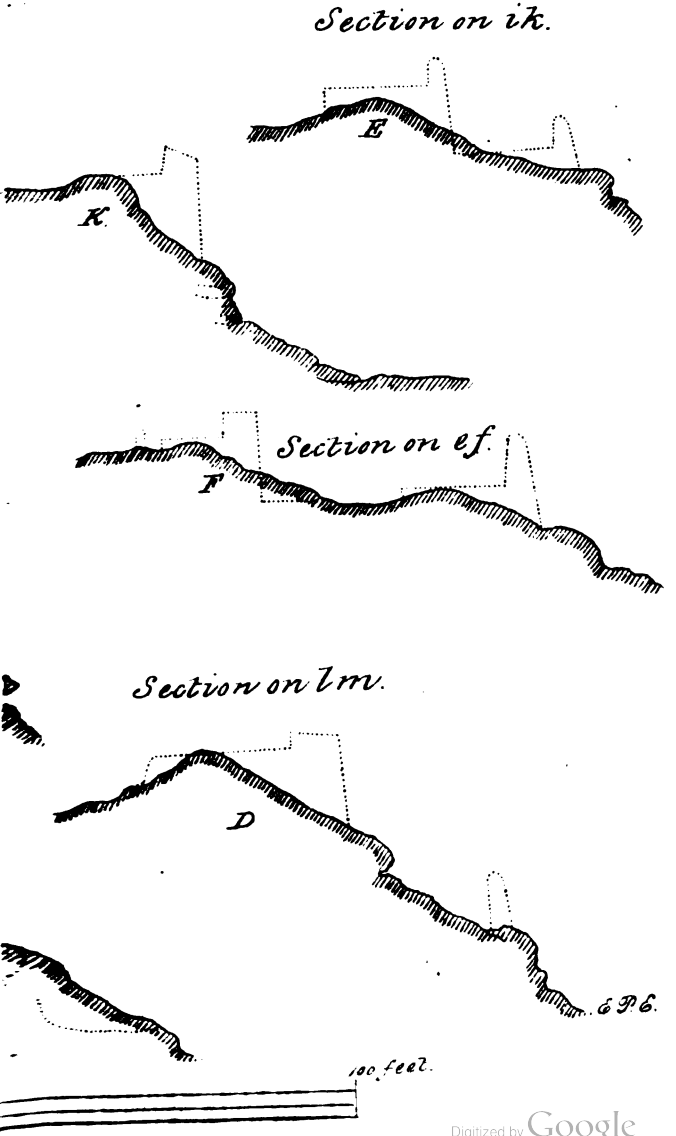








Digitized by Google



Digitized by Google

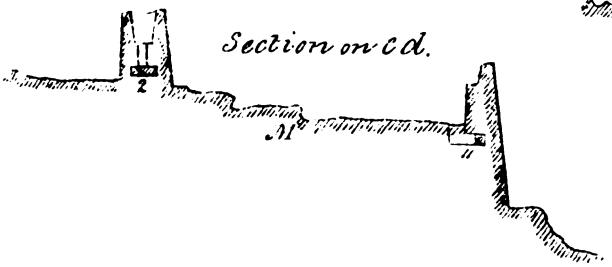
Digitized by Google

Section and Elevation on a b.

Plate 53.



Section on c d.



Digitized by Google

Digitized by Google

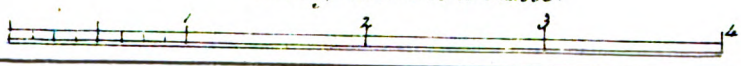
Digitized by Google

Miscellaneous.

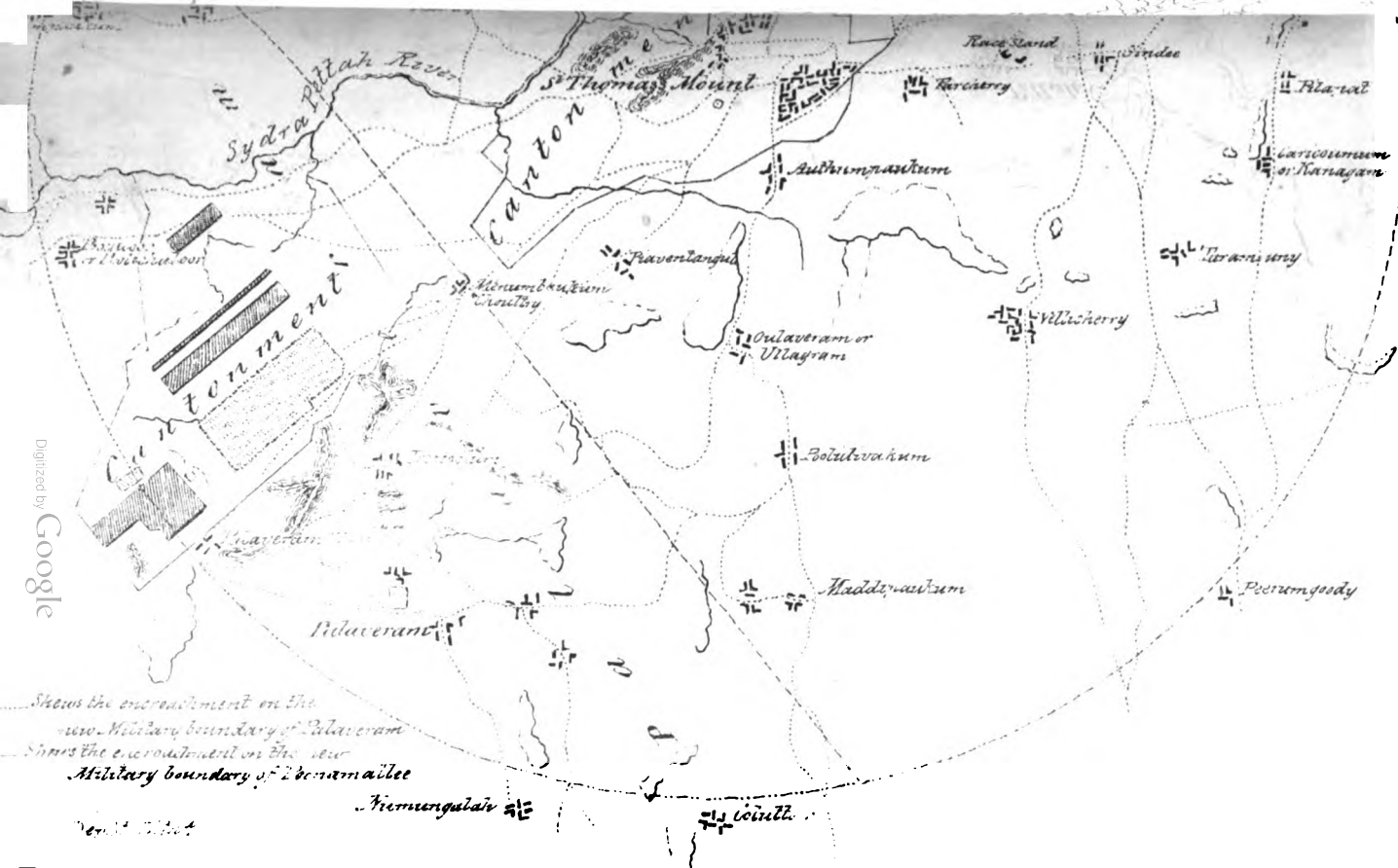
Plate 54

Skeleton Plan of the Cantonment of St. Thomas's Mount defining the new Military Boundary at a Radius of 4 Miles from its Centre.

Scale of 1 inch to a Mile.






Sydrapettah River
St Thomas Mount
Cantonment
Race Stand
Windee
Parcherry
Alandal
Authumpaukum
Carcoumum or Kanagam
Kaypoor or Poonamallee
Praventangul
Veerumbaukum Cavalry
Taramony
Villicherry
Oulaveram or Ullagram
Cantonment
Boludevakum
Pavaram
Maddavaukum
Peerumgoody
Pulaveram
Shews the encroachment on the new Military boundary of Pulaveram
Shews the encroachment on the new
Military boundary of Poonamallee
Veerungulair
Colatti

Digitized by Google

TABLE *shewing the general dimensions of the Shafts, Galleries and Chambers, the average lengths of the lines of least resistance, and charges of the Powder of the Mines employed in dismantling the Fort of Gudjundaghur, in the Southern Mahratta Country.*

NORTH EAST FRONT—PLATES 49, 50.

No. of Mine.	Depth of shaft in feet.	Length of gallery in feet.	Chamber in feet.	L. L. R. in feet.	Charges of powder in lbs. Madras.	Charges of powder in lbs. Country.	REMARKS.
1	0	18	5	15	200	300	The effect of this mine was good, a great mass from the corner, as also the parapet about, being brought down.
2	0	12	$3 \overline{\parallel} 3$	$11\frac{1}{2} \overline{\parallel} 11\frac{1}{2}$	$35 \overline{\parallel} 35$	$65 \overline{\parallel} 65$	These mines were fired with good effect, the whole terreplein with its supporting revetment was brought down, and a breach of a steep slope was formed throughout.
3	0	12	$3\frac{1}{2}$	$11\frac{1}{2}$	50	100	
4	0	12	$3\frac{1}{2}$	$11\frac{1}{2}$	50	100	
5	0	12	$3\frac{1}{2}$	$11\frac{1}{2}$	50	100	
6	0	12	$3 \overline{\parallel} 3$	$11\frac{1}{2} \overline{\parallel} 11\frac{1}{2}$	$35 \overline{\parallel} 35$	$65 \overline{\parallel} 65$	
7	0	11	$3\frac{1}{2}$	$10\frac{1}{2}$	20	60	An experimental mine, the first that was fired, the charge proved too small, merely blowing out the foot of the wall in a small crater without injuring the upper part.
8	0	20	$3\frac{1}{2}$	13	0	500	From the crater of No. 7, a gallery was run to lay charge No. 8, which was intended to shatter the gateway, it completed the line of breach of Nos. 2 to 7, but the gateway suffered but little.
9	0	12	$3\frac{1}{2}$	$11\frac{1}{2}$	85	215	This charge was increased to enable it to injure the gateway the explosion was very violent, and had the desired effect.

Digitized by Google

NORTH EAST FRONT,—Continued.

No. of Mine.	Depth of shafts in feet.	Length of Gallery in feet.	Chamber in feet.	L. L. R. in feet.	Charges of Powder in lbs. Madras.	Charges of Powder in lbs. Country.	Remarks.
10	0	12	3½	11½	40	110	Formed a similar line of breach to mines 2–7.
11	0	12	3½	11½	40	110	
12	0	12	3½	11½	40	110	
13	0	12	3½	11½	40	110	
14	0	12	3½	11½	40	110	
15	0	18	4½	14	85	215	Similarly placed to No. 1, had good effect, bringing away the corner, charge decreased because it overhung the Town.
16	0	0	0	0	0	0	This shaft continually fell in and was abandoned.
17	22	12	4 / 3	10 / 8	0	300	Had good effect, corner of escarp and flank walls, entirely brought down, and the earth in rear much shaken.
18	0	0	0	0	0	0	Shafts continually falling in were abandoned.
19	0	0	0	0	0	0	
20	18	0	7	8	0	150	These mines fired in succession, brought down the whole line of escarp which is of masonry of great strength, each stone weighing from 4 to 6 tons.
21	18	0	7	8	0	150	
22	17	0	7	8	0	150	
23	14	0	7	8	0	150	
24	12	0	7	8	0	150	
25	15	0	5	9 ... 9	0	150	
					0	250	The counterscarp is mostly cut out of the rock, this corner is however of stonework, this the mine quite carried away.

NORTH EAST FRONT.—continued.

26	18	0	7	11 ··O·· 11	0	400	Masonry very strong, the mine was effectual in removing the corner as required without violence.
27	0	6	1¼	4	0	60	The utter demolition of the gateway by blowing away the abutments was completely effected by these mines.
28	5	0	1½	3½	0	60	
29	20	0	3	6	200	800	The large charges of these mines were necessary, from the badness of the ground and the impracticability of proper tamping, the shafts being wide mouthed pits. Their effect was as required, removing the entire flank wall and the earth in its rear.
30	25	0	3	7	200	800	
31	20	0	7	varying from 16 to 20 feet.	0	500	The breaches formed by mines Nos. 2-14, being very steep, and the parapets above, though shattered remaining in some places, these 12 mines were arranged to render the breach of an easier ascent. They were fired in succession, and had the required effect, forming large craters, and rendering the whole breach practicable.
32	20	0	7		0	500	
33	20	0	7		0	500	
34	20	0	7		0	500	
35	21	0	7		0	500	
36	20	0	7		0	500	
37	22	0	7		0	500	
38	20	0	7		0	500	
39	20	0	7		0	500	
40	20	0	7		0	500	
41	20	0	7		0	500	
42	20	0	7		0	500	
43	26	0	6	15	0	600	Similar to Nos. 29 and 30 charges decreased, as the tamping was better, and they overhung the town. The effect was as required bringing down entire flank wall.
44	20	0	8	15	0	600	
45	11½	0	2½ ○ 3	6 ○ 8	0	100 ○ 150	A large breach formed quite through the rampart.
46	0	10	7	12	0	500	Previous explosions had so weakened the earth that these mines could not be worked further. The abutments of the gateway were only greatly shattered instead of being destroyed.
47	0	7	7	8	0	300	
48	0	6	8	0	0	200	Were run from a recess in the subt. passage and their chambers formed as the rock would admit. L. L. R. is very uncertain.
49	0	10	3	0	0	200	

Digitized by Google

NORTH EAST FRONT,—Continued.

No. of Mine.	Depth of shaft in feet.	Length of Gallery in feet.	Chamber in feet.	L. L. R. in feet.	Charges of Powder in lbs. Madras.	Charges of Powder in lbs. Country.	Remarks.
50	0	0	7 7	0	0	200—200	Was a double chamber driven from a recess, and formed as the rock would admit, its L. L. R is therefore very uncertain.
51	0	12	4	11½	0	200	These galleries driven into the side walls of subterraneous passage, were strongly tamped, and the hose was so arranged that these mines together with Nos. 46-50, should be fired simultaneously, this was done, and the passage was completely destroyed throughout its length
52	0	12	3½	11½	0	200	
53	0	12	4	11½	0	200	
54	0	12	4	11½	0	200	
55	0	12	4	11½	0	200	
56	0	12	4	11½	0	200	
57	0	12	4	11½	0	200	
58	15	0	5	10	0	250	To destroy the curtain of strong masonry between bastion C and the gateway. The charge of No. 59 was doubled to enable it, if possible, to bring down part of the gateway.
59	15	0	5	10 ó....10	0	500	
60	26	0	3 ○ 7	6 ○ 13	0	100 ○ 500	To act against the other side of gateway. The effect of these 2 large charges Nos. 59 and 60 was only to cause the gateway to crack and split throughout, the stonework is so very large.
61 to 67	0	0	0	0	0	0	Galleries were attempted here, but proving great labour, they were abandoned and shafts (69-74) commenced above.
68	0	0	0	0	0	0	Explosion of mine in bastion A rendered this unnecessary.
69	16	0	6 ○ 8	10 ○ 5	50 ○ 20	200 ○ 80	The curtain between bastions A and B, was quite destroyed by these two mines, fired simultaneously.
72	16	0	7 ○ 8½	10 ○ 5	50 ○ 20	200 ○ 80	

71	24	0	5	10	100	400	These four mines were fired in pairs, and with No. 60 quite destroyed the long curtain between bastion B and the gate, the masonry is of enormous size and well built. No. 71 charge was doubled as it was some distance from B.
72	22	0	5	10	60	240	
73	24	0	5	10	60	240	
74	24	0	5	10	60	240	
			4	19	0	600	This bastion is solid, paved with stones, and built of very large and strong masonry. The north chamber could not be carried further than 4 feet, from the size of the stones composing the interior, the explosion was quite effectual without any violence, bringing down the entire bastion, the construction of the shafts &c. occupied 2 months.
A	32	0	7 ✣ 7	16 ✣ 16	0 ✣ 100	400 ✣ 300	
			7	16	100	300	
			12	16	50	450	This bastion was throughout of solid masonry, the shaft was with much difficulty and labour carried nearly to the rock and the charges determined by rough calculation. The explosion completely carried away the whole bastion exposing the rock below to view.
B	25	0	12 ✣ 12	20 ✣ 16	100 ✣ 50	900 ✣ 450	
			12	20	150	850	
			6	15		500	The parapets of this bastion were unfinished. It was of solid stone throughout; and the sinking of the shaft of a work of great difficulty. The explosion quite destroyed the bastion carrying the greater part down the hill. The masonry was of great size.
C	28	0	6 ✣ 12	15 ✣ 15	0	500 ✣ 500	
			10	15		500	

Digitized by Google

WEST FRONT.—Plates 51, 52.

No. of Mine.	Depth of shafts in feet.	Length of Gallery in feet.	Chamber in feet.	L. L. R. in feet.	Charges of Powder in lbs. Madras.	Charges of Powder in lbs. Country.	Remarks.
1	16	0	4	13	0	500	These 4 mines were fired simultaneously, and were very effectual, the whole bastion being blown down, and the rocky foundation exposed. The sinking of the shafts was very laborious, the bastion being mostly stone.
2	16	0	6	12	0	500	
3	19	0	4	12	0	500	
4	19½	0	4	13	0	500	
5	10½	0	6 ◇ 5		0		This connecting curtain is of strong masonry, the shafts all reached the rock at small depths, the mines were fired simultaneously and the explosion was violent but quite effectual in removing the works between bastions J. and K.
6	11	0	6 ◇ 5		0		
7	13½	0	4 ◇ 4	9 ◇ 7	0	300 ◇ 200	
8	15	0	4 ◇ 4		0		
9	14	0	4 ◇ 4		0		
10	15	0	6 ◇ 6	10 ◇ 10	0	300 300	The bastion was unfinished to the rear, and could only be mined in this one point. The charge was increased, as proper tamping was impracticable, and was quite ineffectual.
11	25½	0	5	18	200	800	This large bastion (I) with the adjoining rampart was composed of enormous stones varying from 6 to 8 tons each, and is filled up with firm gravel. The shafts were sunk with ease to the rock, and chambers formed on its surface. The mines Nos. 12, 13, and 14, were fired simultaneously, the rest in succession. The explosion were moderate but completely brought down the whole work.
12	19½	0	5	14	100	400	
13	19	0	5	13½	100	400	
14	19½	0	5	14	100	400	
15	19½	0	6 ◇ 6	12 ◇ 10	100	320 ◇ 320	
16	18	0	6 ◇ 6	10 ◇ 8	80 ◇ 80	240 ◇ 160	
17	17½	0	4½ ◇ 6	10 ◇ 7	60 ◇ 40	240 ◇ 160	

Digitized by Google

WEST FRONT,—Continued.

18	14¾	0	6	15	200	800	The bastion D. was unfinished to the rear. The 2 shafts reached the rock at a small depth, the charges were found to be too large as the explosion was very violent. The effect was however, quite as could be wished.
19	15	0	6	15	200	800	
20	14½	0	7	From 8 to 10 feet,	0	200	The shafts here were but irregular wide mouthed pits constantly falling in, 3 mines were fired simultaneously, No. 22 was intended to act against the gateway in concert with
21	15	0	7		0	150	
22	16	0	7		0	300	
23	13½	0	5	9	0	300	No. 23 which was quite successful, the gateway with the flanking tower being completely destroyed.
24	0	0	0	0	0	0	Was intended to assist No. 23 in destroying the square tower flanking the gate, but it fell in so constantly that it was at length abandoned.
25	12	0	4⅛	Varying from 5 to 8 feet.	0	100	
26	12	0	4½		0	100	
27	13	0	4¼		0	100	
28	11	0	4⅕		0	100	
29	11	0	4½		0	100	
30	13	0	4⅓		0	100	Bastion G and the adjoining lines of curtain, to destroy which these mines Nos. 25 to 45 were arranged, are built interiorly of large loose stones, in consequence of this, the shafts sunk are but irregular pits and the exact L. L. R. in each is therefore uncertain. The charges were increased throughout, as it was required to scatter the works. The effect of the mines was good, throwing down the whole line into a practicable breach, and without much violence. The mines were fired in succession.
31	14	0	4½		0	150	
32	17	0	4½		0	150	
33	17	0	4⅓		0	150	
34	15	0	4½		0	150	
35	16	0	4		0	100	
36	14½	0	4		0	100	
37	12½	0	4½		0	100	
38	12⅓	0	4⅓		0	100	
39	14⅐	0	4⅕		0	100	
40	15⅕	0	4⅕		0	100	
42	14¼	0	4		0	100	

WEST FRONT,—continued.

No. of Mine.	Depth of shafts in feet.	Length of Gallery in feet.	Chamber in feet.	L. L. R. in feet.	Charges of Powder in lbs. Madras.	Charges of Powder in lbs. Country.	Remarks.
43	16	0	4	varying from 5 to 8 feet.	0	100	
44	14	0	4		0	100	
45	14	0	4		0	100	
46	17	0	4½	9	0	150	Were fired simultaneously, throwing down the whole bastion; being similarly constructed to bastion S. the shafts were of equally difficult construction, but the L. L. R. may be given with greater exactness.
47	14	0	5	8	0	150	
48	16	0	5½	13	0	300	
49	16	0	5	11	0	300	
50	17½	0	7	10	0	150	These three mines quite destroyed bastion F, the soil was good and the shafts were easily sunk, the mines were fired simultaneously.
51	19	0	5	13	0	300	
52	18½	0	7	10	0	150	
41	16	0	7	From 12 to 13 feet.	0	300	The wall against which these mines were arranged is of bad construction, and much bulged in some places. The charges have therefore been decreased, the effect of these 8 mines which were fired in pairs, as nearly as possibly simultaneously, was to bring down the whole line successfully. No. 59 had an increased charge to assist 23 against square tower.
53	14	0	8		0	300	
54	15½	0	7½		0	300	
56	19¾	0	7		0	300	
56	20	0	7		0	300	
57	21½	0	7		0	300	
58	17	0	7		0	300	
59	17	0	6	14	0	500	

Digitized by Google

BASTION L.—Plate 53 B.

1	18½	0	7	11	0	500	Bastion L is built of immense stones, and filled in with made earth, and well paved with stone, the shafts were sunk without much difficulty (Nos 1 and 5 to the rock) and the mines were fired simultaneously with good effect, throwing the whole bastion down the hill without violence, and shaking the adjacent curtains.
2	21¼	0	5½	12½	0	500	
3	17	0	5½	13	0	500	
4	21¼	0	7	12	0	500	
5	16¾	0	4½	13	0	500	

SOUTHERN GATEWAY, Plate 53, A.

1 2	7½	0	3 / 3 3 3 / 3	3 / 3 3 3 / 3	0	25 / 25 25 25	The shafts were sunk to the rock, and four chambers made in each. The mines were fired in succession, and their effect was to destroy completely both the towers, but the arched gateway though somewhat injured remained standing.
3	11	0	7	From 8 to 10 feet	0	75	The wall here, though high and well cemented, is of no great strength, and was completely demolished by the explosion of these 4 mines, fired in quick succession; No. 4 was rather violent from a water drain crossing the L. L. R.
4	15½	0	6		0	150	
5	15½	0	6		0	150	
6	15½	0	6½		0	150	
7	16	0	5 / 5 5 / 5	6 / 6 6 / 6	0	50 / 50 50 / 50	In a bastion constructed on a feature of rock, the shaft was carried to the rock and 3 chambers formed. The mine without any violence removed the whole bastion, exposing the rock.
8	15	0	4½	5	0	50	This mine had the required effect, of destroying a scarp of masonry built up in a cleft of the rock.
9	7	0	5½ / 5½ / 5	5 / 5 / 5	0	50 / 50 / 50	This shaft was an irregular pit, however, the mine was effectual in completely destroying the angle of the work.
10	9	0			0		Also a bad shaft, but the charge produced the required effect.
11	4½	0	7	4½	0	100	Carried under foot of wall to its centre on the surface of the rock, it was necessary to increase the charge from the size of the masonry
12	19	0	2 3	8 6	0	150 100	Somewhat similar to No. 7, the mine effectually removed the small bastion down the hill.
13	11	0	3½	6	0	100	A larger charge placed here, to enable the mine to act laterally against the vaulted chamber.

Digitized by Google

SOUTHERN GATEWAY,—continued.

No. of Mine.	Depth of shafts in feet.	Length of Gallery in feet.	Chamber in feet.	L. L. R. in feet.	Charges of powder in lbs. Madras.	Charges of powder in lbs. Country.	Remarks.
14	20	0	6 ◇ 6	6 ◇ 6	0	100 ◇ 150	The shaft was sunk to the rock, the charge in the eastern chamber was increased to enable it to assist No. 10, in destroying the vaulted chamber, opposite old gateway.
15	3	0	8	6	0	100	Intended to destroy the inner line behind No. 14, the masonry in this line is exceedingly large and strong.
16	3	0	7½	average 6 feet.	0	100	
17	4½	0	8		0	100	Afterwards added, to carry on the breach in the interior line, were fired in quick succession, and were quite effectual in dislodging the large stones.
18	5	0	8		0	100	

BASTIONS O, and P. Plate 53 C.

1	16	0	9 ◇ 9 / 9	10 ◇ 10 / 10	0 ◇ 0 / 0	100 / 150 ◇ 150 / 150	The bastion was completely swept down the hill by this mine, and its rocky foundation exposed.
2	16½	0	3 ◇ 6	6 ◇ 12	0 ◇ 150	100 ◇ 100	This double mine was intended to bring down the ramp, and to blow in the wall of the vaulted chamber. The effect was not quite equal to expectation, though the vault was ruined.
3	16	0	3	8	50	50	To destroy the angle of the ramp leading up to the bastion.
4	17½	0	7	Average of 11 feet.	150	100	These 4 mines with No. 8 were fired simultaneously from the centre of the bastion. Their effect was to destroy nearly all the stonework, and so to shake the earth in rear, as to render it an easy matter to complete the demolition by hand.
5	17½	0	7		150	100	
6	16	0	7		150	100	
7	19	0	7		150	100	
8	20	0	7	10	150	100	Here the wall was higher and no earthern slope, the mine accordingly was very efficient bringing down the whole.

EXPLANATION OF THE SYMBOLS USED IN FOREGOING TABLES.

 A gallery with a double chamber at its extremity.

 A shaft, having at its foot, on one side a chamber, and on the opposite side, a gallery with a chamber at its extremity.

 A shaft with a double chamber at its foot.

 A shaft having at its foot, 4 galleries or chambers running in opposite directions.

 Do. with 3 galleries or chambers.

With reference to the preceding Tables, it may perhaps be necessary to offer some explanation, of the apparent want of rule in the calculation of the charges, of the rough statement of the dimensions of the various shafts, galleries, &c. and of the lengths of the several lines of least resistance. The whole quantity of Powder employed in the demolition of the Fort was about 55,000 lbs. of which only 6,000 lbs. were from Madras, the remainder was of country manufacture, a sample of which, when proved at the Arsenal at Belgaum, gave a range of 28 feet instead of 500. This Powder has however proved of quite sufficient strength for mining operations, though of course its effect could not be calculated upon with the exactness of the Madras. In addition to this it must be known, that the construction of the works at Gudjundaghur varies so greatly at different points, that the nature of the wall to be mined, was much more to be taken into consideration in the calculation of the charges, than any ascertained line of least resistance.

The workpeople employed at the mines &c. were mostly common biggaries from the neighbouring villages, they were superintended at their work by a N. C. O. of Sappers and Miners, 2 Artificers of the Engineer Department, and some Store Lascars, a sufficient supply of Engineers working tools were obtained for carrying on the work, but it was considered impracticable to attempt blasting in the construction of the shafts &c. which were obliged to be sunk, with great labour to their required depths, by breaking the stonework with heavy shot found in the Fort.

Digitized by Google

The progress of the work by these means was slow, sometimes only 6 inches in a day and the shafts &c. thus constructed were necessarily very irregular, indeed some of those in the west front were only wide mouthed pits.

With regard to the manner of loading and firing the mines, when the shaft or gallery with its chamber was completed the charge was laid in the chamber in sandbags, containing 50lbs. each, without any precaution against damps, as the season was favorable, and the mine generally fired as soon as it was ready, a one inch linen hose, being then attached and secured to the centre bag, was carried through hollow bamboos carefully fitted, and secured with lashings to the mouth of the shaft or gallery. The charge was then covered with a double row of sand bags, and if it was a gallery, the whole was carefully built-up with mud and stones, from the sandbags to the entrance, but in a shaft it was only built for 2 or 3 feet from the charge, and then the excavated material was thrown from the top, only ramming occasionally. When the tamping was complete, a piece of portfire was attached to the end of the hose, of sufficient length to allow the man who lit it, to escape, and the junctions of the hose and portfire having been carefully covered with cowdung as a precaution against sparks, the fire was applied.

From the above account of the manner in which the works at Gudjundaghur were carried on, it will be seen that no fixed rules for conducting similar operations could be framed from these. This report however, may perhaps prove useful as a reference, should any works of demolition against places of a similar nature, be ever required.

Digitized by Google

ABSTRACT OF THE PROCESS OF MANUFACTURE OF GUN-POWDER IN THE BOMBAY POWDER WORKS, BY MAJOR W. JACOBS, AUGUST 1842.

The proportion of ingredients are as in the Royal Mills in England and as in Bengal, viz. 75 Nitre, 15 Charcoal, and 10 Sulphur.

Nitre.—Is at present received in a refined state from the Ishapore Powder Mauufactory at Calcutta, and stands the Bombay Government in as delivered in the Powder works at Mazagon, at 17 Rs. 3 As. 11 P. per 100 pounds.

Melting proof.—On delivery each batch is tested with nitrate of silver and if found pure as it hitherto always has been, it is fuzed; and when in a liquid state, ladled out into the Copper Moulds or vessels for receiving it, out of which when cold it is turned—each holding about 38lbs. This rids the nitre of *the water* of crystalization and facilitates the pulverizing and sifting process. It is bruised and pulverized in light cylinder mills drawn by one Buffaloe, and sifted through lawn seives for incorporation.

Sulphur.—The sulphur is obtained from England and is debited to the Manufactory at 8 Rs. 4 As. 10 P. per cwt. It is fuzed, skimmed, and poured out into moulds to separate the centre or pure stratum from the scum and sediment portions, which latter are reserved for the subliming process. The pure sulphur is then pulverized in cylinder mills drawn by one Buffaloe, and passed through lawn seives for use.

Charcoal.—Charcoal is made from the Dhalstalk which costs as delivered at the Manufacture 6 maunds or 168 lbs for the Rupee. It contains twigs and rubbish and yields as prepared for burning about 80 per cent of wood for charring and the proportion of charcoal, taking an average of 3 years prior to 1839, was about 12 per cent, subsequently it has been found occasionally to yield 18 per cent of the Dhalstalk in the state it is purchased.* There are 3 cylinders forming one furnace; and 3 hours suffice for their burning, each cylinder will hold about 95 pounds of unburnt prepared Dhalstalk or about 17¼ lbs. of charcoal.

Incorporation.—The ingredients having been thus purified and prepared for incorporation, are weighed out in the pro-

* According to different experiments tried, the weight of charcoal to prepared Dhalstalk i. e. as barked and cleaned for burning, has been 21 per cent 26·7 per cent and 22 per cent.

Digitized by Google

portion of, nitre 60 lbs. sulphur 8 lbs, charcoal 12 lbs. making 80 lbs. for one charge of the trituration barrels.

Triturating or mixing barrels.—These barrels 6 in number (4 at present suffice for our work) are turned by 2 men each, with 2 men spare per barrel, protected from danger of explosion by strong masonry pillars, the spindle which turns the barrels passing through the masonry pillar—a muccadum superintends the whole, with a minute glass occasionally to try the work, the barrels should be revolved for 2 hours from 15 to 17 times per minute. In each barrel are 4000 brass bullets of a size 64 to the pound.

Heavy Cylinder Mills.—The above 80 pounds form one Mill charge, and it undergoes 300 revolutions in about 2½ hours, each cylinder weighs nearly 6 tons, and they work by pairs in a trough so elevated above the workmen and cattle as not greatly to endanger them in the event of explosion; 3 pairs of cattle are employed at a time on each mill charge, the composition is watered before beginning with three pints of distilled water with a fine rose water pot, and after 200 revolutions with another pint (making in all 5 per cent.) indicated by the ringing of the bell in a self acting "*tell tale*" above, which revolves with it. In the monsoon 2lbs. of distilled water instead of 3lbs. are used before beginning. The bell in the tell tale similarly rings to indicate the completion of the 300 revolutions.

Press House.—The mill cake used formerly to be bruised and pulverized in a light single cylinder, it is now bruised by hand rollers and taken to the Press House, where 500lbs. of composition form one press charge.

Before the introduction of the new granulating machine in 1841, this press charge (500lbs.) formed 25, twenty pound cakes, divided by double sheets of copper, the composition was ¾ inch thick, as put into the press and it was pressed down to ½ inch thick cake, we now make 50 ten lbs. cakes pressed from ½ to ¼ inch thick, to adapt it to the rollers of the granulating machine, the composition is left one hour under this pressure (estimated as equivalent to 1000 tons) formed by a powerful iron screw with lever and windlass, and about 3 hours are occupied in filling, pressing, and emptying one charge; 1 muccadum, and 12 men in the monsoon, and 15 men in the dry months are employed on two presses, and during the interval they take away the cake and bring fresh composition.

Digitized by Google

Airing the Cake.—In the dry weather the cake is aired on Powder cloths spread upon a broad bamboo scaffolding, over which a mat awning preserves it from the too rapid effect of the direct heat of the sun,—2 hours suffice for each charge, in the monsoon time this process is of course intermitted. The cake in the dry weather is stored in the "cake houses" each cake put upright and prevented touching the adjacent cake by two pieces of composition dropped between. In the monsoon the press cake is broken and all barrelled up and kept in this state in the magazine of the manufactory.

Granulating Machine.—In the fine season the press cake is broken into small pieces of from 1 to 3 inches, with mallets, and conveyed to the new granulating machine where it is reduced to the size of Fine and Cannon Powder with the loss of about 1½ per cent, which is blown away, and about 20 per cent of dust is remilled, and along with fresh composition again pressed into cake. The proportion of Cannon to Fine grain Powder resulting from this process is about 3 of Cannon and 1 of Fine Powder.

The machine requires 2 buffaloes at a time to work it, charged every hour, and the following men viz.

1 Muccadum to superintend.

Outside.
- 2, Drivers.
- 1, turning the supply reel.
- 1, supplying cake.

Inside.
- 1, at the top of the machine to adjust the cake on the upper roller.
- 1, below to replace barrels as filled and to attend the sieves.
- 2, convey broken cake to, and grain from the machine.
- 2, spare to relieve the rest.

Corning House.—The granulated composition is then passed through sieves suspended by leather thongs, from beams in the corning house to separate the Cannon from the Fine.

The Cannon Powder is all grain that passes through 10 holes to the inch and rest on top of 18 holes to the inch sieves.
The fine 18 „ „ „ 36 do.

Glazing House.—The grain is then glazed in 8 reels 125 lbs. weight being put into each reel, which are revolved from 15 to 17 times in the minute for 3 hours.

We here use 8 reels employing on them, 1 Muccadum and 16 men daily, (in the dry season only.)

Digitized by Google

Drying Terraces.—After glazing, the Powder is thoroughly dried on 8 chunam terraces for 4 days from 10 till 2 o'clock, over the polished chunam Powder cloths are spread and the Powder is raked to and fro, by from 12 to 15 men.

On the 4th day of drying the grain is sifted in common gauze sieves suspended from the beam by leather thongs to separate any remaining dust, and when perfectly cool it is proved and handed over to the Commissary.

LARGE GUNS FOR EGYPT.

One of the large guns made for Mehemet Ali having been mounted on a strong ship carriage, constructed at the Royal Arsenal, it was resolved to make some experiments previous to its being sent to Deal. The carriage on which this magnificent gun has been placed is mounted on a sliding platform 20 feet in length, to afford ample room for recoil to the carriage when the gun is fired, and the whole has been placed on a base similar to the deck of a ship, or war steam-vessel, with pieces of iron forming part of a circle, on which the ponderous gun and carriage can be moved from one side to another according to the direction in which the gun may be required to be pointed. The angle on which the sliding platform was placed, is so inclined forwards as to require the united power of 16 men to draw back in the direction of the recoil the carriage and gun 6 feet, but it only required six men attached to the pulleys, and two to the levers, to bring up the gun and carriage to their original position after being fired. After the various exercises of the gun in moving it from one direction to another, and retiring and advancing it as might be required when loading, were gone through in a manner to the entire satisfaction of the Officers present, the gun was loaded with a charge of 26lbs. of Powder and a solid ball of 130lbs. weight. The first shot fired caused the gun and carriage to recoil about 5½feet, and the second shot only half an inch more, with the same charge of Powder.

The third shot had a charge of 29lbs. of Powder and the recoil exceeded the former by 6 inches. The fourth shot with a similar charge, recoiled only 5¾ inch more than the first two shots. The fifth and sixth shots, with a still greater charge of Powder, recoiled, the one 15 inches, and the other 17¾ inches more than the first, but leaving ample space on the sliding platform to insure that it was sufficient for the heaviest charge that might even be applied.

Digitized by Google

INDIAN FIELD CARRIAGES ON SERVICE IN SCINDE.

Letter from Captain J. T. LESLIE, *Commanding 1st Troop Bombay Horse Artillery, dated Camp near Peshawur, 12th November* 1842, *to the Adjutant of Artillery, Sukkur.*

Fort William G. O. No. 214 of 1843. dated 26th August 1843.

Having observed by Government General Orders of 14th September last, that the Block Trail gun carriage in use with the Bengal Artillery is ordered to be introduced generally throughout India, I feel it my duty with reference to the circumstances under which this carriage may have had a preference to that recommended by the Select Committee of Artillery Officers, assembled in Calcutta during the years 1837-38, to report specially to the Commandant of Artillery on the battery under my charge; for although I have not been called upon, on any occasion, for such report, yet I conceive, that having marched with this Battery from Kurrachee, through the whole of Affghanistan, including three times through the Bolan Pass, and once, over perhaps, the most difficult and trying road, for wheel-carriages, that has ever been traversed before, namely,—from Caubool, through the Koord-Caubool, Gundamuck, and Khyber-passes to Peshawur, it is highly necessary that a Record of the working of the battery under such circumstances, should be laid before the Commandant of Artillery, or deposited in the office of the Select Committee of Artillery Officers in Bombay.

2. The battery in charge of the 1st Troop, consisting of 4 Light Field Gun Carriages, and 6 Ammunition Waggons, was received in October 1840, just as the Troop was proceeding on service to Affghanistan; and having been made up in the Gun Carriage Department from a drawing of the Committee Carriage, which was subsequently sent from Calcutta to Bombay, it was, I believe, considered defective in many parts: I myself in a report forwarded to the Secretary of the Select Committee in Bombay in November 1841, pointed out some of these defects, and amongst them I mentioned that the wood had shrunk a good deal from the Ironwork, in consequence of not being properly seasoned; the wheels also, were, in my opinion, badly constructed; but notwithstanding the defects there pointed out, and a few minor ones subsequently ascertained, I have no hesitation in pronouncing the Committee Gun Carriages, the best I have yet seen in

Digitized by Google

the service. It has invariably stood the heaviest firing at all angles without injury ; the Nave, which is generally objected to, as inferior to the wooden ones, by Officers who have not before seen it in use, has never in a single instance required the smallest repair ; the Trail is nearly as light again in limbering up, which, I have over and over again ascertained, whilst serving with the Bengal Artillery ; a point, I consider, of great importance, in quick manœuvring ; in fact the general construction of the Carriages, is, in my opinion, as near perfection as possible, and all the minor alterations might easily be made without affecting the principle upon which the Carriage is constructed.

3. With regard to the Ammunition Waggon, I have found them unusually heavy in draught and I am of opinion, that, the position of the boxes on the body of the waggon, which have been thrown by the Committee, much more in advance of the Axletree, than in the old waggon, is the cause of this, as well as of an increased strain upon the Perch ; in fact, as far as I have ascertained in seeing the Bengal and the Committee Ammunition Waggons together, that the former is considerably lighter in draught, and upon the whole of a lighter construction than the Committee Waggons ; it should be remembered however, that the Bengal Ammunition Waggon carries only (16) sixteen rounds, where as the Committee Waggon caries (20) rounds per box.

4. In reporting this, however, I have no fault to find with the limber of the Ammunition Waggon, nor with the wheels, nave, or any other part of the Carriages save what I have already mentioned.

Digitized by Google

LIMBER FOR PONY DRAFT AT NINGPOO.

Letter from Lieut. MOLESWORTH, *Madras Artillery, dated 28th February* 1843, *to the Director Artillery Depôt.*

As you expressed a wish some time ago when I saw you, to have a plan of the Pony Limber which was used with the Mountain Train in China, I have great pleasure in sending you the accompanying with a few remarks by way of explanation Plate 55.

It having been determined to use the ponies or small horses of the country, to move our small mountain train in China, a number of them, about 40 or 50, were collected at Ningpoo and broken in, a portion of them for draught, and the remainder to carry Ammunition boxes. The Royal Artillery had brought some harness with them on the expedition which, with a little alteration, was made to fit the Ponies. As no limbers had been sent with the mountain guns, we tried at first to move our guns without them, by working on the trows to the washer hooks, and stationing a steady man at the traversing handspike at the trail to guide the piece. This plan however was found not to answer, as the guns (particularly in turning when the train is only on one trow) were constantly upsetting. The next plan that was tried, was fixing shafts to the trail of the carriage; this answered very well on even ground, but if the truck supporting the trail came in contact with a mound of earth (such as the bund between two paddy fields) or a slip &c. owing to the smallness of its diameter it would jam, and the gun was then immoveable until the trail and truck were lifted over the obstacle. Moreover as there was generally a considerable jerk when the guns were thus suddenly brought up, the pintails of the trucks frequently snapped, or else were so much bent as to prevent the Truck from turning about; after these failures it was determined to build limbers: at first we found more difficulty from the want of wheels; however, by using the wheels of two spare carriages that were sent out with the guns, and cutting down some large 9 pdrs. and 24 pdr. Howitzer wheels, we mustered sufficient to complete 6 limbers. After a variety of kinds of limbers had been proposed, the one of which I send you a plan was adopted. The wheels as I mentioned above were either of English or Indian manufacture altered to a lesser diameter in China. The body of

Digitized by Google

the limber was made of a light, but close grained wood something resembling Ash, and peculiar to China. The shafts were made from the poles of their sedan chairs, which we found tough, light, and springy, they are also made of a wood of the country something like lancewood but lighter. The Gun was attached to the limber by a pintail placed at that part of the limber that I have marked P. The pintail passed through the socket in the trail of the carriage intended for the truck which was of course previously removed. These limbers were found to answer very well. They were put to a severe trial in a long march over a very difficult country, from Woosung to Shanghae, a distance of 15 miles, when scarcely a single accident or upset took place, and these only in a part of the country which was nearly impassable. I had charge of the Ponies both on shore, and was embarked for several months with them on board ship, and found them to be hardy, gentle, and nearly indefatigable.

Hoping that the above is sufficiently explanatory and clear.

Digitized by Google

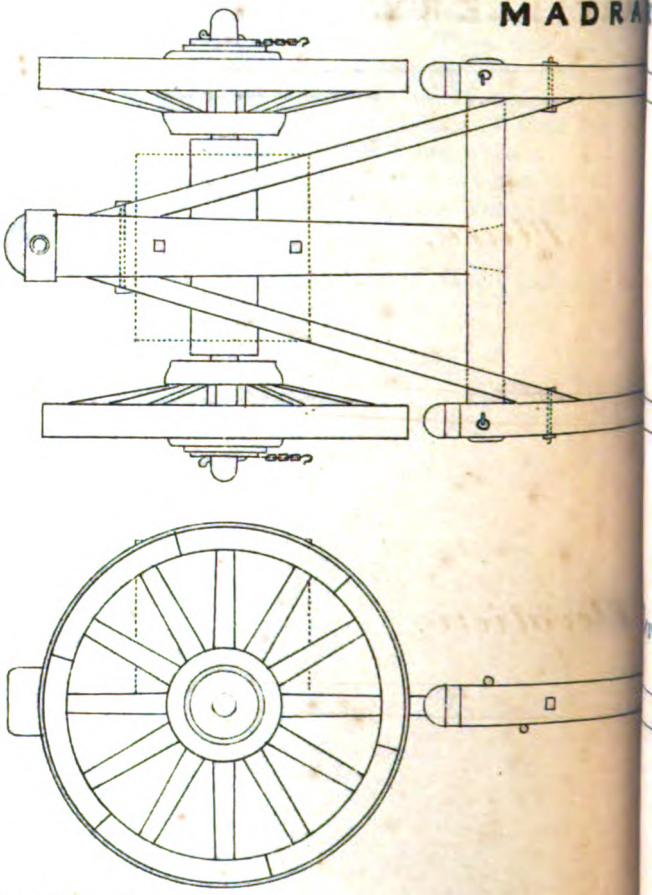
Digitized by Google

Mis

3 Pdr. Limb

used

MADRA



P

Artill.y Depôt lith.ª

Inches 12 9 6 3 0

Digitized by Google

ellaneous.

r for Pony Draught
Ningpo
by the
I ARTILLERY.

Plan.

Elevation.

6.9.6.

Scale.
2 3 4 5 Feet.

Digitized by Google

Digitized by Google

EVILS OF DETACHING A SINGLE GUN, ON SERVICE.

The narrative of the events at Cabool subsequent to the insurrection, published in the *Englishman*, affords, in that portion copied in our issue of to-day, a remarkable instance of the evil of neglecting the Standing Orders of the service. Independent of the narrator's remarks, it must be sufficiently evident to every practical man, that the disasters which occurred to the force on the 23d November, and which had so seriously injurious an effect upon the future proceedings, was to be mainly attributed to the circumstance of a single gun having been taken out on that occasion. Had two or more been in the field, they might, by their alternate fire, have supported each other, and kept down the destructive vollies from the enemy's jezails, the effect of which seems to have been so deadly and so much dreaded. As it was, one piece was of no use, save to swell the triumph of the enemy by its capture, and to exhibit the staunch and gallant spirit of the little band who were in charge of it whose conduct was worthy of the corps to which they belonged. The evil and absurd effect of this system of employing a single piece, has always been pointed out by Artillery Officers, although they have been occasionally overruled by the authorities in command; but so far back as 1806, by the General Orders of 6th November of that year, the attention of Commanding Officers was called to the necessity of having an adequate supply of artillery on all occasions, where guns are found, or are likely to be found necessary; the order in question concluded in the following terms:—"But on no account is any such service to be undertaken without a suitable equipment of the kind above directed (Guns); and which is therefore to be supplied, in the first instance, when there may be a probability even of its being required. On all occasions of field service that a gun may be deemed necessary, two guns are invariably to be sent." Some years afterwards, consequent on certain disastrous results arising from a neglect of this most salutary rule, the Marquis of Hastings, then Commander-in-Chief issued the following order, dated the 26th February, 1815, and which order is still in force:—

"It is with much regret the Commander in Chief has observed, that notwithstanding repeated prohibitions, the

Digitized by Google

" practice of detaching a single gun on service has not been " wholly laid aside in the army : in reiterating this prohibi- " tion, his Lordship announces his determination to take the " most exemplary notice of the conduct of any Commanding " Officer who shall hereafter be guilty of so unmilitary " an act." Notwithstanding this strict interdict, we regret to state that this very objectionable system was more than once adopted with the force at Cabool.

Digitized by Google

MEMORANDUM ON CHINESE GUNPOWDER BY MAJOR MOORE, C. B. MADRAS ARTILLERY, 2ND MARCH 1843.

The object in comparing the ranges of Chinese powder, with that manufactured at Madras, was not only to discover its relative strength, but also to ascertain if it could be usefully employed in filling common shells. The shells used for this experiment were made up in weight to 15 lbs.

The mortars were placed upon a dry paddy field; on reference to the table it will be seen, that the ranges given bythe conical chambermortar, although its windage was double that of the gomer, exceed considerably those of the latter, especially where the Chinese powder is concerned. The great increase of range which was obtained by increasing with the conical chamber mortar the charge of Chinese powder from 6 ozs. to 9 ozs. is another exemplification of the fact, that coarse grained powder, though badly manufactured, and made of impure materials, the Chinese saltpetre was indifferent, will nevertheless in large charges approximate more nearly in its effects, to well made powder, than could have been expected.

TABLE *of ranges of Madras and Chinese Powder from* 5$\frac{1}{2}$ *inch conical and gomer chamber Mortars. Elevation* 45°, *each Mortar weighing* 1*cwt.* 3*qrs.*

No platform used.

Gomer chamber Mortar—windage $\frac{9}{10}$ inch.							Conical chamber Mortar—windage $\frac{4}{10}$ inch.						
	Madras			Chinese				Madras			Chinese.		
Rounds	ozs.	drs.	yards	ozs.	drs.	yards	Rounds	ozs.	drs.	yards	ozs.	drs.	yards
1	6	1	472	3	0	12	1	4	6	372	3	0	16
2	7	0	600	4	0	27	2	5	8	575	4	0	45
3	8	0	682	9	0	78	3	6	0	628	6	0	80
4	9	0	846				4				9	0	356

Digitized by Google

CHINESE ENGINEERING AND ARTILLERY.

In the science of engineering, the Chinese are very far behind the rest of the world; of this science, indeed they seem to have but a partial knowledge although frequently in the selection of positions for their defences they exercised considerable judgment.

In Artillery they are very backward, their guns being of enormous weight in proportion to their calibre; some of the pieces of Ordnance which we recaptured weighing 7 tons, although only 42 pounders, yet notwithstanding this immense thickness of metal, in many cases the guns burst. At Anunghoy we found all the guns furnished with sights, and some of the heavy guns captured at Canton had elevating screws; but I much doubt the gunners being sufficiently scientific to use these aids properly. In their field batteries a magazine is placed in the rear of each gun and is merely a deep hole in the earth having another larger one close by for the gunner to lay down in after firing. The carriages are almost clumsy and owing to this they are unable to train the piece to bear on any particular object, but fire it off point blank. Latterly, however, they used better guns, purchased from the Americans and Portuguese, the heavy guns at Canton being all of foreign manufacture. Their gunpowder, though by no means deficient in strength, nor in the proportion of its component parts, is coarse and bad.

They appear to have no idea of the nature of a shell, none having been found in their arsenals. Two brass howitzers were taken, from which I suppose they would have thrown hollow shot, as great stores of shot of that description were found in Anunghoy for the large brass and iron guns, together with granite, marble and chain shot, which latter was used in all the guns. In defending the entrance to the forts they used a species of hand grenade made of clay, and filled with combustibles of a composition resembling the carcass of a shell as it resists the influence of water. Another horrid grenade they used was a vessel in the shape of a tea-pot filled with the most offensive materials. After lighting the match at the mouth of this, they throw it down and thus break the pot when the match igniting the contents produces a perfume not the most pleasing to the olfactory nerves. Some of the Artillerymen are armed with a stick furnished at one end with a sling for throwing a stone which they project to a considerable distance, and with tolerable precision.

Digitized by Google

Their rockets are the merest child's weapon, being not above six inches long fastened on a slender bamboo shaft and armed with a barb inserted at one end. These are fired from a frame resembling the infernal machine making a great noise but doing no harm.

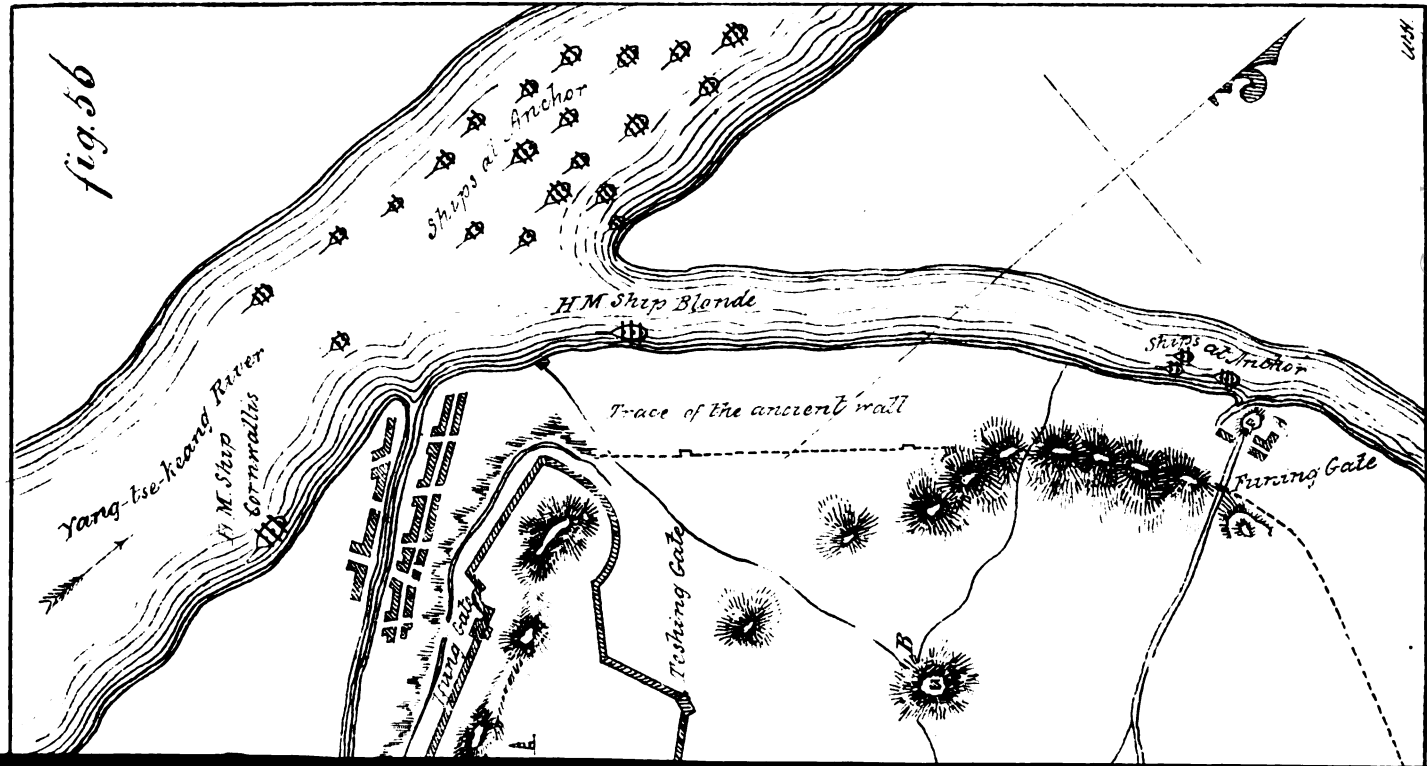
STEVENS' WAR STEAMER.

The Steam Battery, or vessel, is to be constructed upon a plan entirely new, invented by Robert L. Stevens, and is to be shot and shell proof; she is to have greater speed than any vessel of war now afloat; the engines and propelling apparatus are to be so placed that the latter shall be submerged, and the whole engine out of the way of shot from the vessel of an enemy. Her guns are to be large, and adapted both to shot and shells; her burden not to be less than 1500 tons. The practicability of rendering such a vessel proof against shot and shells is not a theoritical assumption, but has been proved by the test of positive experiments. These experiments were recently made at Sandy Hook, under the superintendence of Messrs. John C. and Edwin A. Stevens, and in the presence of a joint board of armyand navy officers, appointed by the Government. From their result no doubt whatever remains of the fact that a series of wrought iron boiler plates, rivetted together and placed upon each other, until the strata amount to four inches and a half in thickness, will effectually resist the force of the 64 lb. shot when fired with battering charges at the distance of thirty yards. Fifteen or twenty shots were also fired at this distance, and from guns of different calibres, against a target thus constrncted, and were made to strike against it within a space of about two feet by four; and these produced so little effect as to leave it in a fit state to protect anything in its rear against a similar force. Shells fired from the same distance scarcely indented the iron, and *both shot and shells were invariably broken into small fragments.*

Digitized by Google



Digitized by Google

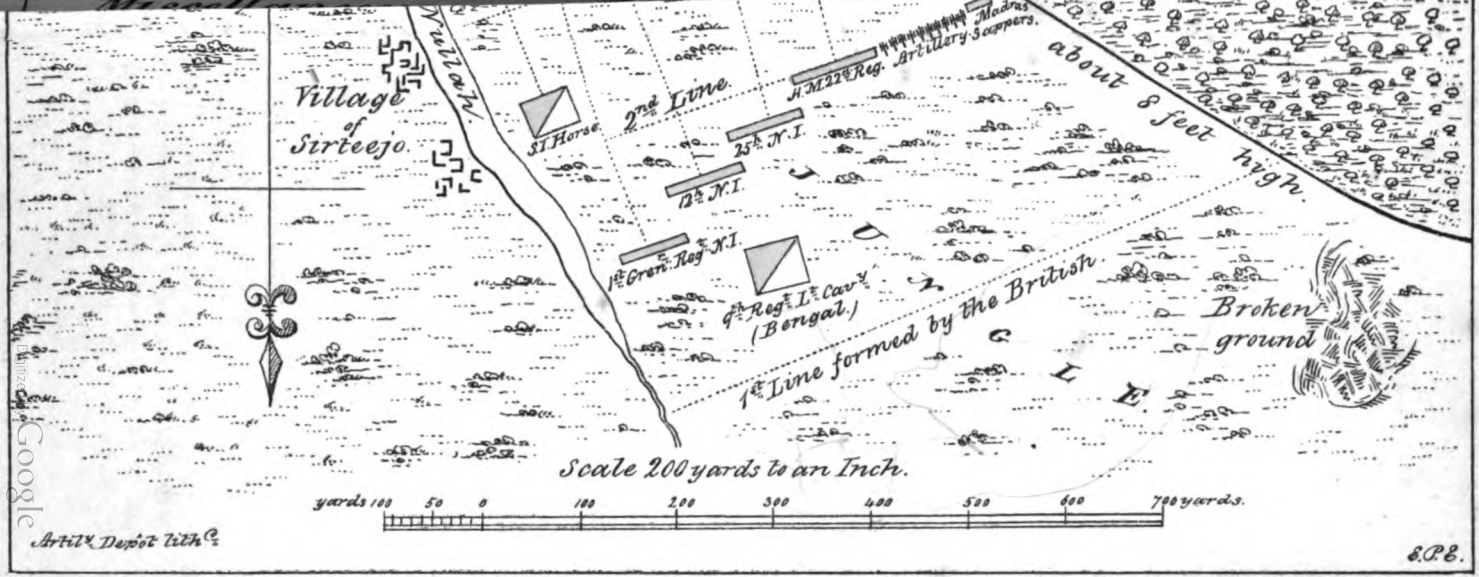


Digitized by Google

Digitized by Google

Digitized by Google

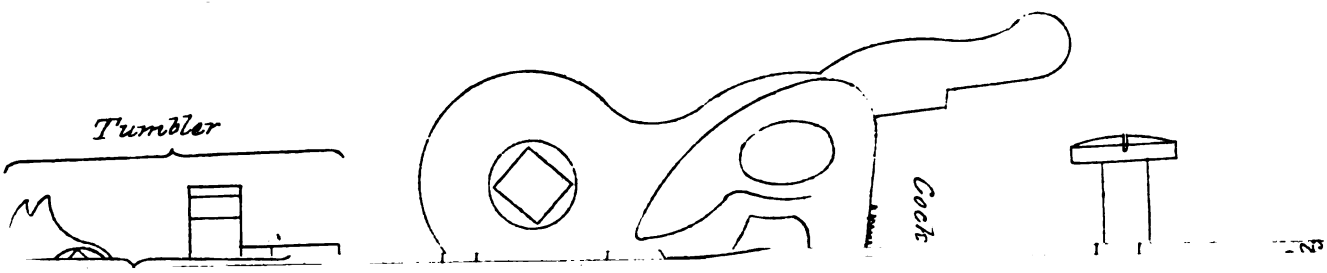
Digitized by Google



The British Troops are all coloured red, and those of the Enemy blue. The Troops advanced in Echellon from the 1st to the 2d 3d & 4th Lines. The British Troops had 12 Guns in the Field 2 of which were left with the Baggage. After advancing from the 1st Line there were never so many as 8 Guns in Action and in the 4th Line there was room for only 4 to be brought into Position. The bank of the River lined by the Enemy was about 12 feet high and very rugged. The Battle commenced at 9 A.M. and lasted till [illegible] P.M. on the 17th February 1845.

(Signed) Robt Henderson Bt Capt
Comg C. Comy Madras Sapr & Mnr

Digitized by Google

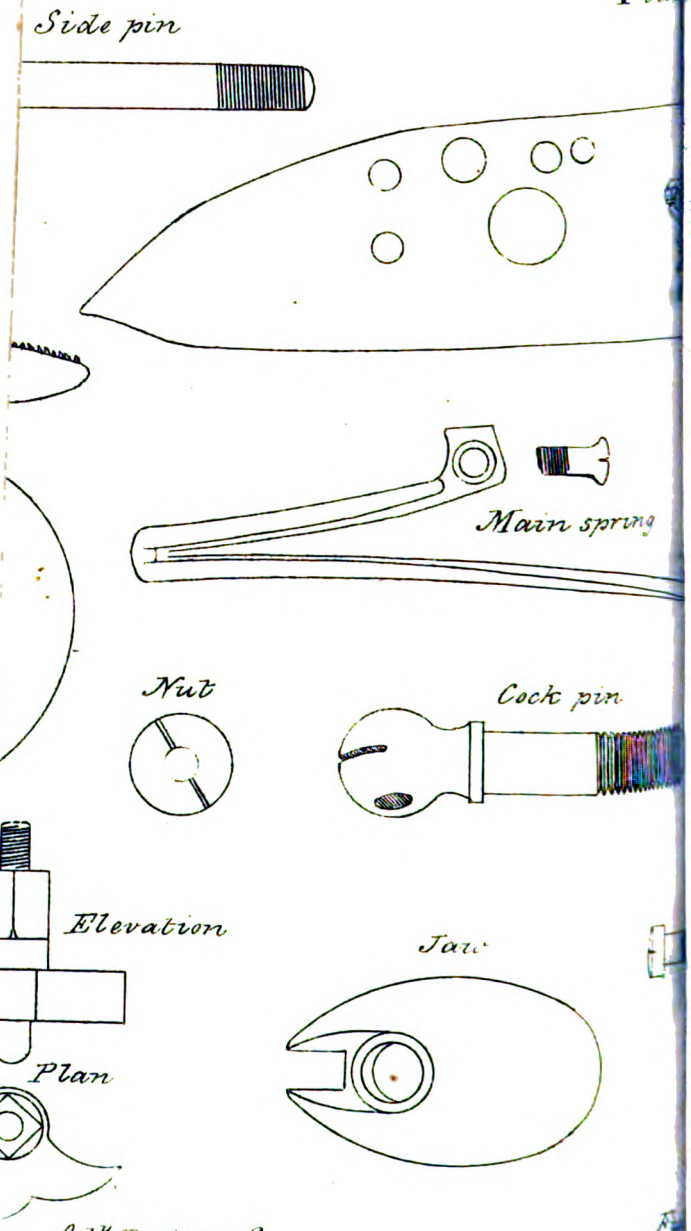


Digitized by Google

Miscell

Smal

Flin



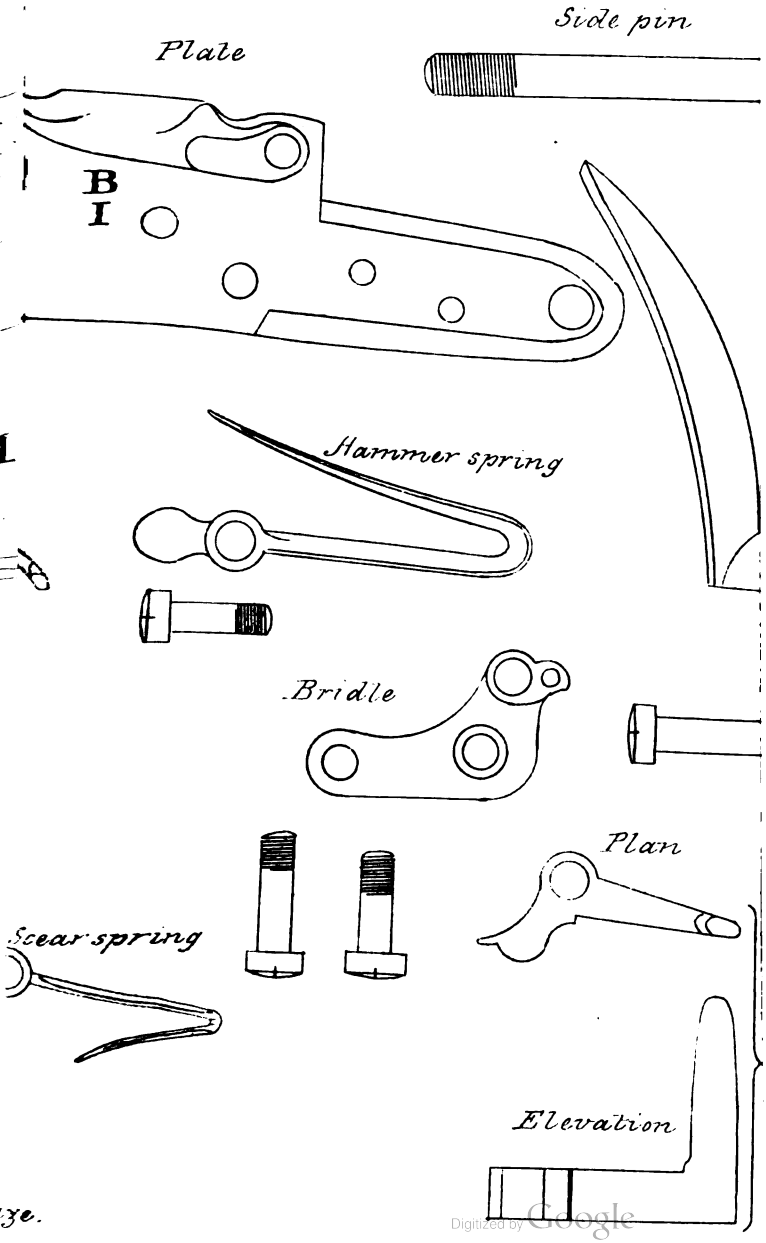
Art.y Depôt lith.?

Digitized by Google

veous.

ms.

ck.



Digitized by Google

Digitized by Google

BATTLE OF MEEANEE NEAR HYDERABAD IN SCINDE, 1843.—*Plate* 58.

Letter No. 42 *from Bt. Captain R. Henderson, Commanding C Company Sappers and Miners; to the Adjutant Madras Sappers and Miners Bangalore, dated Fort Hyderabad,* 25*th February,* 1843.

I have the honor to report for the information of the Officer Commanding the Corps that the Detail of my Company as per margin, were present under my command in the action which took place on the 17th, instant near the village of Katree, when the Force under the personal command of Major General Sir C. Napier was advancing upon Hyderabad.

2	Lieutenants
1	A. Apothecary
2	Corporals
2	Jemadars
2	Havildars
3	Naigues
48	Privates
1	Bugler

We left our encampment near the Town of Mittaree at 6 A. M. of the 17th instant. In the column of route the place assigned to us was at the head of a working party consisting of my men and 100 Infantry of the line in front of the advance guard. We had to make a practicable road for Artillery across several irrigation canals, when having proceeded to a village distant from Mittaree about 6 miles, we became aware that the enemy were near and intended to oppose our progress. The whole of the working party and advanced guard, including two guns, were immediately thrown forward, the guns being in the centre occupying the village, and the Infantry extending to the right and left. The position of my Detail was on the right where we lined a portion of a bank close to the dry bed of the river Foolaylee, on the other side of which was a thick forest or Shikargah. The main body was immediately halted and the General proceeded in advance with a Regiment of Irregular Horse for the purpose of discovering the enemy and reconnoitering his position.

We had not been long in this position when we heard the sound of the enemy's guns, who had opened their fire upon the Irregular Horse, and shortly afterwards an order was brought for the Infantry of the working party to join their respective Regiments, and for the Sappers to remain with the Artillery which was ordered to advance. The road lay along the bank of the river Foolaylee and the services of the Sappers were required several times to enable the guns especially those of the Camel Battery to pass, at last the whole of the Artillery consisting of one horse and mule, and one Camel Battery, were brought into position. The Sappers were posted on the right of the Artillery at the extremity of the line. The Infantry were formed in line on the left of the Artillery and about 30 paces in rear, when the action commenced on our side by a cannonade of round shot from our guns at a dis-

Digitized by Google

tance about 1,000 or 1,100 yards from the enemy's position. I should here mention that whilst our Troops were being brought into position, the enemy kept up a fire upon us from two points which proved to be the right and left of their position.

After a few rounds from each gun the whole line advanced for about 300 yards, when the Artillery again opened, and after this Skirmishers were thrown out and the whole advanced to a 3rd position about 300 yards in advance, when the guns were again brought into action with Canister and Shrapnell. The next advance was that of the whole line to the bank of the dry bed of the river Foolaylee, where the enemy were in great force and a desperate conflict ensued. The enemy having fired a volley with their matchlocks threw them down and with swords and shields, rushed up the bank under which they had hitherto been concealed and penetrated into the ranks of the Infantry where they were slaughtered. For some time the issue of the contest appeared to be very doubtful, as the men who advanced fought with desperation and were evidently the flower of the enemy's Army and resolved not to give way, but they could not stand against the murderous fire of British musquetry and at last they fell in heaps, while those that took to flight were pursued by the Cavalry which now crossed the river near the village of Katree. Whilst this was going on toward the left the Sappers assisted in getting the guns into position in the broken ground on the right, in which direction the enemy were rushing into the Shikargah with the intention of availing themselves of its cover to turn our position, and many of them approached as close under cover of the wall as to annoy the Artillery greatly, some of the gunners were shot at their guns as also several of the Men of H. M. 22d Regt. who were on the left of the Artillery. Those of the Sappers who were armed immediately fired over the wall at the enemy, and those with working tools commenced destroying the top of the wall in order to get a better fire over it. This had the desired effect and the Artillery no longer annoyed by the enemy's Matchlocks, poured sucha destructive fire in the direction of the Shikargah, that the enemy abandoned their intention and the rout was now complete. They fled in all directions pursued by our Cavalry, every gun they had was taken, their ammunition was left on the Field, their camp was left standing, and in it was found their treasure, stores and other valuable property, the whole of which fell into our hands. The Infantry crossed the river and the Artillery followed taking up position No. 5 on the South bank, and the guns again opened on the right upon a large body of the enemy's horse who made their appearance in that direction, but after a few rounds they all moved off. The firing

Digitized by Google

now ceased, the day was ours, the Cavalry returned from the pursuit, our baggage was brought up in the rear and we pitched our camp close to the spot where the enemy had left their tents.

After the battle was over our men were still kept employed as we were ordered to destroy the enemy's ammunition and gun carriages which we effected in the bed of the river Foolaylee.

The number of the enemy is calculated at 21,000 men at the least, and they had 14 pieces of Artillery which fell into our hands. We halted on the 18th in our camp close to the scene of action, on which day the Meers delivered themselves up to Sir C. Napier. On the 19th we arrived at Hyderabad where the Army collected 10 more guns besides large quantities of grain and other property.

On the 21st the British colours were hoisted on the highest Tower of the Fort of Hyderabad, and all public property inside was seized including Treasure, Stores, Jewels, Arms and from 80 to 90 guns of all calibres.

It affords me great pleasure to record and lay before the Officer Commanding the Corps, the valuable assistance I received from Lieutenant Outlaw and 2d Lieutenant Boileau attached to the Company, who were present with the men during the whole of the day, encouraging them by their own personal example in whatever service was required to be performed. The men behaved with great gallantry and performed with great endurance the arduous services they were called upon to perform during the long and eventful day. The Officer Commanding will observe that most of my men were called upon to take part in a most severe action without arms to defend themselves as they merely carried their working tools. I would also beg to remark that the bayonet knife at the end of the Fuzil with which the men were partially armed, appears to be a most inefficient weapon, if not a great incumbrance, as it was found almost impossible to make it penetrate through the clothes generally worn by the enemy opposed to us.

The accompanying sketch will show the nature of the country where the battle was fought, and serve to illustrate the foregoing remarks.

1st OR MAJOR LESLIE'S TROOP, BOMBAY HORSE ARTILLERY.

Extract from G. O. G. G. dated Agra, 11th April 1843.

"The Governor General having taken into consideration "the peculiar merits of the 1st Troop of the Bombay Horse "Artillery under Major Leslie, which having participated in

Digitized by Google

" the distinguished services of the army of Candahar, under his " Excellency Major General Sir W. Nott, G. C. B., and having " returned to India with the Troops from Cabool, marched from " the Camp of Ferozepore early in January and joined the " army of Scinde, in time to decide, in conjunction with H. " M.'s 22d Regiment, the battle of Hyderabad, is pleased to " direct, that the 1st Troop of the Bombay Horse Artillery " shall hereafter for ever be denominated the 1st, or " Leslie's " troop of Horse Artillery, and shall, in addition to all other de- " corations or inscriptions upon itsappointments, bear the " Eagle." "

DRIVERS OF BOMBAY ARTILLERY, NOTICED FOR THEIR CONDUCT IN ACTION.

Extract from a Notification, by the Right Honorable the Governor General of India, Political Department, Agra, the 15th March 1843.

" The Governor General is further pleased to direct, that " the drivers attached to the 2d Company 2d Battalion; 3d " Company 3d Battalion of Bombay Artillery, in the battle of " Meeanee, shall be entitled to the pension of Sepoys."

Letter from Major General Sir C. J. Napier, K. C. B. to the Right Hon'ble Lord Ellenborough, Governor General of India, dated Hyderabad, 2d March 1843.

I beg leave to send to your Lordship reports made by my order, that while the memory is fresh, distinguished deeds may be put on record. The great results of this battle have made me anxious that those who were so conspicuous in the hour of trial *should* be known to your Lordship. Their devotion to their duty was very honorable to them.

In the case of the brave drivers of the two Batteries, I am sure your Lordship will do them justice, and I beg especially to recommend them to your Lordship's protection.

Letter from Captain G. Hutt, Commanding Field Battery, to the Adjutant of Artillery in Scinde, dated Camp near Hyderabad, 23d February 1843.

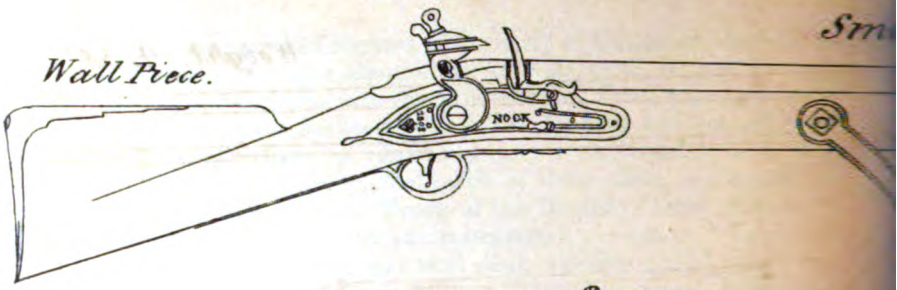
I would not presume to bring these men to notice were they enlisted, or treated as fighting men, but as they are still considered as mere followers, men whose families receive no pension in the event of their death, or themselves, if disabled by wounds, I beg to submit the case to the Major General, as a strong argument in favor of those, on whose courage and conduct the very existence of the Battery must often depend.

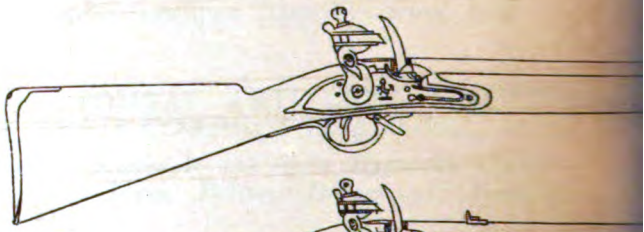
Digitized by Google

Digitized by Google

Miso

Sm

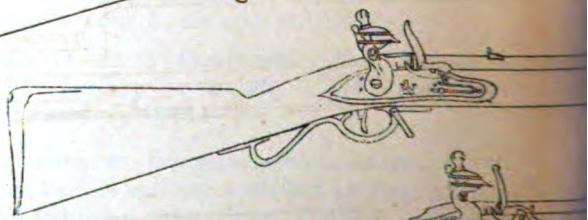


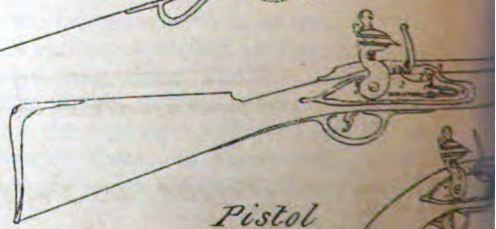










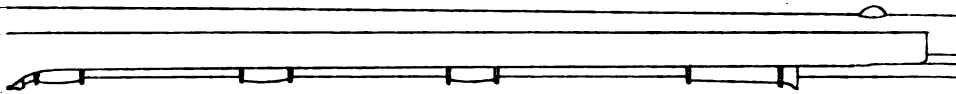


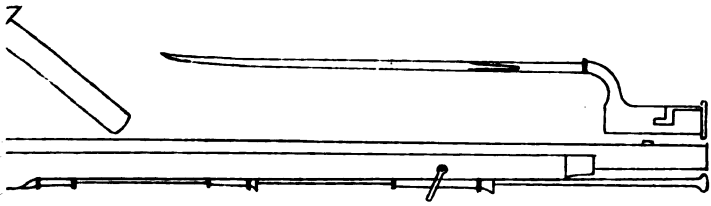
Digitized by Google

laneous.

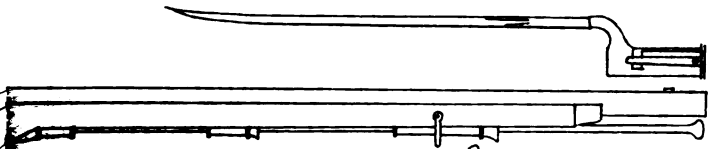
Arms.

Weight. lbs 38

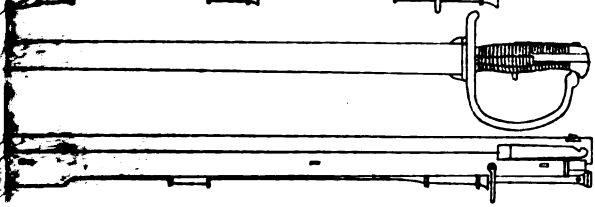




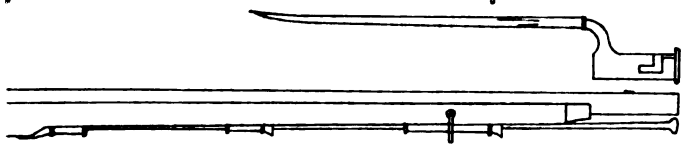
Weight
lbs 11 oz 1 drs 13



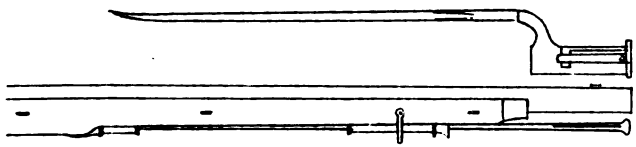
Weight
lbs 10 oz 3 drs 6



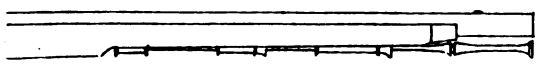
Weight
lbs 11 oz. 2.



Weight
lbs 8 oz. 12 drs 1



Weight
lbs 9 oz 8 drs 11



Weight. lbs 7 oz. 2 drs 3



Weight. lbs 3 oz 2 drs 10.

1 inch to a Foot.

Digitized by Google

Digitized by Google

THE ENGLISH STANDARD YARD.

It is usual to refer all our measures of length to the Standard Yard, which has been determined by modern science with rigid exactness; indeed, so necessary is it to know the precise length of our yard, that some of the sciences which are now among the beautiful and the true, and beautiful because true, owe their very lustre to the precision with which our instruments measure lengths and capacities of various kinds. In a rude state of society the standard measure of length was some natural object, and as such, it was liable to constant variation; thus the yard itself was a measure of the length of the arm of one of the early Kings of England (it is said of Henry the First, in 1101.) Again, three grains of barley placed end to end were taken as the measure of an inch, thirty-six of which went to the yard. Now this seems to imply that the arm of a King ought to be just as long as 108 barley-corns, but as we all know that neither Kings' arms nor barley-corns, are always of the same length, it is obvious that this method was not adapted to much precision; advancing science called loudly for some unerring standard, for some rule which would have all the rigour and truth of a principle which could be appealed to in after ages, so that the accidents of fire, storm, or tumult, and the many casualties to which our lineal measures are subject, might not prevent posterity from deciding the real meaning of our distances, whether in the records of history or science.

In 1760 a brass standard measure of one yard, made by Bird, was deposited with the clerk of the House of Commons, and in so far it gave an uniformity to the length of the yard in this country, but still no general principle was known by which that yard could be replaced if lost; and it was not untill 1824, that an undeviating rule was laid down, which, by being based upon scientific principles, became available for after ages, as well as for our own times. Its origin is briefly this. The science of Astronomy informs us, that the length of the day and the night, taken together, does not vary; also, that when a pendulum is made to vibrate, the time that it occupies in moving from side to side (which motion is called a vibration) is due altogether to its length, and has nothing to do with the quantity or quality of the matter of which the pendulum is formed. It follows, therefore, that all pendulums of the same length will perform the same number of beats or vibrations in the same time, with this especial pro-

Digitized by Google

viso—that the observations are made at places all having the same terrestrial latitude. This condition is rendered necessary by a change in the force of gravity, which occurs with every change of latitude. Centrifugal force is an antagonist power to gravitation, and is greater at the equator than at any other latitude, on account of the greater diurnal velocity of the surface of the earth at the equator: hence the force of gravity is diminished, and the number of pendulous oscillations in a second likewise diminished, or, which amounts to the same thing, the length of a pendulum to vibrate in a given time, must be reduced as we approach the equator. Thus,—at London, which is in latitude 51° 31′, the length of the seconds' pendulum must be 39. 1393 inches, while at Stockholm, in latitude 59° 20′, the length is 39·1654 inches. If, therefore, we note the number of beats in any one day of any number of pendulums of equal lengths, they will all be found equal to each other, the latitude remaining the same: and if we suppose a pendulum of a given length to vibrate as many times as there are seconds in a day of twenty-four hours, i. e., 86,400, and if the length of such pendulum be called a yard, any Mathematician or Astronomer in after age could ascertain what is the length expressed by the term yard with the greatest degree of exactness, since all he would have to do, would be to get the length of a pendulum vibrating 86,400 times in a day. The length of such a pendulum would not, however, be our yard; but, if its whole length be divided into 391,393 equal parts, 360,000 of such parts are taken as the yard, so that the pendulum vibrating seconds is longer than the yard by $\frac{1}{3}\frac{1}{9}\frac{3}{1}\frac{9}{0}\frac{3}{0}\frac{3}{0}$ parts. This ratio between the length of the yard and of the seconds' pendulum was ascertained by the late Captain Kater a few years ago, and a bar of platinum was constructed by order of Government, under the direction, we believe, of the same accurate observer, and deposited in the Tower of London. The length of this bar is exactly a yard; all measures therefore in common use may be compared with this as a standard, and corrected; and so long as this standard is carefully preserved, it will not be again necessary to have recourse to the pendulum.

Note. The length of the pendulum at Madras, is for seconds 39·036 inches.

" $\frac{1}{2}$ " 9·759 "

" $\frac{1}{4}$ " 2·439 "

Digitized by Google

FRENCH WEIGHTS AND MEASURES.

The systematical form of the Spheroid, into which the earth is thrown by its diurnal rotation, renders the distance from the equator to the pole physically and almost mathematically equal in every longitude, and in either hemisphere; a meridional quadrant of the earth's circumference is therefore considered as a constant quantity; this is, in English terms, 6,213 miles, 1,450 yards, and is divided into 10,000,000 equal parts, called METRES, each of which is consequently equal to 39·3709 English inches. This mètre forms a nucleus, from which multiples and submultiples branch off to express longer and shorter distances; thus, the decamètre, hectomètre, kilomètre, and the myriomètre, are respectively equal to 10, 100, 1000, and 10,000 mètres, and the decimètre, centimètre, and millimètre, signify the 10th, the 100th, and the 1000th of a mètre; Greek prefixes being employed for the augmented measures, and Latin prefixes for the aliquot parts. This is the standard for linear dimensions, but superficies is reckoned by the ARE, which is a square decametre, of which each side is equal in English to very nearly 32 feet, 8 inches. From this proceeds a series similar to that before given—viz, the miriare, kilare, hectare, decare, are, deciare, centiare, respectively equal to 10,000, 1000, 100, 10, 1, 01, and 001 ares.

From the decimètre cube is derived the unit of measures of capacity for liquid or dry substances, under the name of the LITRE, each side of which is equal to about four English inches square, and from this they have the decalitre, hecatolitre, kilolitre, and the myriolitre, respectively equal to 10, 100, 1000, and 10,000 litres; and the decilitre, centilitre, and millilitre, severally equal to 0·1, 0·01, and 0·001 litres.

For solid substances, the names of the units are different, but the principle is the same, the stere and the decistere being, the former a mètre cube, and the latter the tenth of a mètre cube.

The last link in this connected chain is the standard of weight, which is derived from the mètre thus: the weight of a centimètre cube of distilled water is ascertained at the temperature of its greatest condensation, or 39·38 Fahr. and is called a *Gramme*. From this seven others are derived, which, with it, form a decimal series, thus: myriogramme, kilogramme, hecatogramme, decagramme, *gramme*, decigramme, centigramme, and milligramme, being respectively

Digitized by Google

equal to 10,000, 1000, 100, 10, 1, 01, 001, and 0001 grammes, the gramme being a cube of water whose side measures 0.3937 inches, or rather more than one-third of an inch in length.

Thus we see that, if the English reader impress upon his mind the figures 3937, (which will be sufficient for ordinary purposes,) he will be enabled to translate French weights and measures into equivalent quantities expressed in English inches, by observing where to place the decimal point; for example,—

	English inches.
Myriomètre..... =	393700·
Kilomètre..... =	39370·
Hecatomètre..... =	3937·
Decamètre..... =	393·7
Mètre..... =	39·37
Decimètre..... =	3·937
Centimètre..... =	0·3937
Millimètre..... =	0·03937

And if we remember that the measure of superficies, of capacity, of solidity, and of weight, are all derived either from the mètre or one of its aliquot parts, we shall see that the same four figures, 3937, will be an index, available for the whole series of measurements.

It is much to be desired that English weights and measures were assimilated to those we have been describing, as there is now no general principle by which one species of measurement can be readily deduced from another. The custom of ages has, however, so bound up the received standards of weight and measure with the technical calculations of the artificer and of the retail dealer, that any attempts at change on a scale so extensive would meet with obstacles almost insurmountable.

ON THE CORRECT MODE OF MEASURING ALTITUDES.

The different methods that have been adopted are the four following.

1st. By instruments capable of measuring vertical angles, or *geometrically*.

Digitized by Google

2nd. By means of the barometer.

3rd. By the temperature at which water boils at the base and summit of a mountain.

4th. By ascertaining the temperature of springs upon the spot, whose height is to be ascertained.

1st. The first method is both tedious and liable to several inaccuracies. A base line and two vertical angles must be measured, and it will be found that, even with the best instruments, under the most favorable circumstances, and with the most practised observer, the determination of minute vertical angles is, from the influence of horizontal refraction, liable to much uncertainty. Besides, when the vertical angles are ascertained, a knowledge of logarithms and plane trigonometry is requisite, to ascertain the altitude; and although the calculation, to the initiated is extremely easy, to those to whom our paper is addressed it would perhaps seem to be both intricate and involved.

2nd. Torricelli, the celebrated pupil of the "STARRY GALILEO," had no sooner made the important discovery that the column of mercury is sustained in the tube, now called a barometer, by the pressure of the atmosphere, than the famous Pascal subjected Torricelli's explanation to the severe test of measuring the height of the column at different altitudes, sagaciously arguing, that the mercury ought to descend, the higher the instrument was carried.

This crucial experiment was made on the Puy de Dôme, in Auvergne, and upon a high tower near Paris; and in both cases the column decreased according to the elevation of the instrument. Were the atmosphere of the same density throughout, as it is at the surface of the earth, the height, at the temperature of 55°, would be 27,600 feet; and at 32°, only 26,000 feet; but as we ascend, the air expands, from the diminution of pressure, and taking the altitudes in arithmetical, the densities are in geometrical, progression. In other words, in ascending 3½ miles, we have passed through ½ of the atmosphere; 7, through ¾; at 14 miles, the density is only $\frac{1}{16}$; or, were we to be carried up 14 miles in a balloon, there would only be $\frac{1}{16}$ of the atmosphere above us. From such a fact, it is evident that altitudes may be calculated by loga-

Digitized by Google

rithms, because the terms of an arithmetical series are proportional to the logarithms of the terms of a geometrical; therefore, different altitudes above the earth's surface, which we have shown to form an arithmetical series, are as the logarithms of the densities, or of the weight of the air at these altitudes. Different formula have been given by different philosophers, for measuring the altitudes of mountains by the barometer, and among the rest, by the illustrious Laplace, who, by certain experiments that he has introduced, has attempted to embrace the minutest anomalies of atmospheric pressure; but whether or not it may be considered a waste of the powers of calculation, to attempt to ascertain so minutely the volume of a fluid liable to such incessant fluctuation as that of the atmosphere; at least, the formula is too involved for us to attempt in this place to develop it.

It has been shown that, at the temperature of 32°, the equiponderant column of air, of the mean density, as at the surface of the earth, would be 26,000 feet; or in other words, that such a column would balance 30 in. of mercury, and 32 feet of water; therefore, we have the following formula, which we take from Sir John Leslie; "as the sum of the "mercurial columns at the bottom and top of a mountain is "to their difference, so is twice the equiponderant column, "or constant number, 52,000, to the approximate height of "the mountain, in feet." We give an example,

If the barometer stand at 30·091 inches at the bottom of a mountain, and 26·409 at the top, what is the height of the mountain?

30·091 × 26·409 : 30·091=26·409: :52,000 : approximate height.

56·5 : 3·682: :52,000 : 3442 feet, the approximate height of the mountain.

It must be recollected that this is only an approximation; but it would be almost correct, if the temperatures of the mercury and the air, both at the bottom and top of the mountain were 32°. Almost all bodies expand by heat, and therefore circumstances can be supposed, when, although the mercury would fall by being carried up a mountain, still, by an increase of temperature in the higher regions, this ten-

Digitized by Google

dency to fall might be counteracted. And hence the temperatures, both of the air and mercury, become important elements in the calculation.

Mercury expands about a 9000th part of its bulk for each degree of Fahrenheit's scale above 32°, and hence a small addition must be made to the upper column when the temperature at the higher station is lowest. In a much higher ratio, however, does air expand; and hence the correction on that account is of more consequence. Its rate of expansion is one 450th part according to Leslie. To elucidate this by an example;

In August, 1775, General Roy observed the barometer on Caernarvon Quay to be 30·091 inches, the attached thermometer being 60·26 and the detached 60·08°; while on the peak of Snowdon, the barometer stood at 26·409 inches, the attached thermometer being marked 50°, and the detached 47·84, how high is the peak of Snowdon above Caernarvon Quay?

In the lower station, the attached thermometer is 28·26° above the freezing-point, and in the higher 18°, whose difference is 10 26°; hence multiplying 26·409 by 10·26°, and dividing by 9000, we obtain ·030 the first correction, to be added to 26·409; therefore

30·09+26·409+·030 : 30·091—26·439 :: 52,000 : approximate height; that is

56·530 : 3·652 :: 52,000 : 3360 feet approximate height.

In the lower station the detached thermometer is 28·08° above the freezing-point, and in the higher 15·84°, the half of whose sum is 21·96°; and if we multiply 3360 by this, and divide by 450, we obtain 164 to be added, and hence the true height, above Caernarvon Quay, is 3524 feet. The correction for centrifugal force, says Leslie, is 7 feet more. In practice, however, it will be found sufficiently accurate to allow 940 feet for every inch that the barometer falls.

3rd. The temperature at which water boils, depends upon the pressure to which it is subjected. Under the receiver of

Digitized by Google

anair-pump, tepid water enters into ebullition when the exhaustion is great. At the top of Mount Blanc, the highest mountain of Europe, which rises 15,630 feet above the level of the sea, water boils at 184°, or 28° lower than its boiling point upon the shores of the ocean; and Laplace calculates that if $\frac{3}{4}$ of the water of the sea was converted into vapour, its pressure would be so great, that red-hot water might exist, and cover the primitive mountains of the globe (Cuvier's Theory of the Earth, Jameson's ed. p. 340). We have mentioned that under general circumstances the barometer falls one inch for every 940 feet of ascent. Now the boiling point of water changes by a fraction, represented by 1.76°, for every inch that the barometer falls; and hence we obtain an easy rule for calculating heights, by observing the temperature at which water boils at the bottom and summit of the acclivity, whose height we wish to ascertain. For $940 \div 1{\cdot}76 = 535$ feet; and hence the varying of a degree in the boiling-point corresponds to an altitude of 535 feet, which is the number given by the Murrays in their POPULAR CHEMISTRY.

We have never tried this formula practically, but Captain Styles, in the last January Number of Silliman's *North American Review*, states that he found this method sufficiently correct. In a few weeks, however, we shall have it verified, and the results shall be inserted in this Journal.

4th. The cold of winter and the warmth of summer, only penetrate a few feet into the soil, without affecting the general temperature of the springs, which issue from the bowels of the earth. In every latitude there is a height where the temperature would only be 32°, or where snow would for ever lie. At the equator, the curve of congelation is 15,207 feet above the level of the sea; and at the pole, eternal winter reigns. From such facts, an empirical law has been deduced for estimating the altitude of a mountain, by observing the temperature of water, as it issues from its sides. "The allowance in this climate is one degree of Fahren-" heit's scale for every 90 yards of ascent, and for every 100 " yards in tropical regions." We have, therefore, only to ascertain the mean temperature of the latitude at the level of the sea, and the temperature of the spot, whose height we wish to ascertain, subtract the one from the other, and multiply by 270, and we at once ascertain its height.

Digitized by Google

We extract from Leslie's *Elements of Geometry* the following table of mean temperatures, which extend to the whole of Great Britain :—

Lat.		Fahr.	Lat.		Fahr.
50°	Mean temperature at the level of the sea.	53·6°	55°	Mean temperature at the level of the sea.	49·2°
51°	" " "	52·7°	56°	" " "	48·3°
52°	" " "	51·8°	57°	" " "	47·5°
53°	" " "	50 9°	58°	" " "	46 6°
54°	" " "	50·0°	59°	" " "	45·8°

"The temperature of the Crawley and Black Springs, on the ridge of the Pentland Hills, near Edinburgh, were observed, says Leslie, by Mr. Jardine, where they first issue from the ground, to be 46·2° and 45°, which compared with the standard temperature at the same parallel of latitude, would give 567 and 891 feet of elevation above the sea. The real heights found by levelling were respectively 564 and 882, a coincidence most surprising and satisfactory." To enter more minutely into this process :—

"I found the temperature of the water as it issues from Beltow-grain vein, at Wanlockhead, to be 44°, and from this I deduced the elevation as follows:"

"The latitude of Wanlockhead is 55° 20′, the mean temperature of which, according to the above table, is 48·87°; and hence the difference between the temperature at the level of the sea and at Wanlockhead is 4·87°. Again, 4·87°×270=1,334 feet, whereas by other means it has been ascertained that the altitude of Wanlockhead is 1,330 feet."

After a full consideration of the subject, we consider this last method of ascertaining the height of mountains to be by far the easiest; and from what we have shown, it seems to be as accurate as any.

BLACK THE WORST COLOUR FOR PAINTING WOOD WORK IN THE OPEN AIR.

There is nothing that will prove this evil more than by observing the black streaks of a ship after being in a tropical climate for any length of time. It will be found that the wood round the fastenings is in a state of decay, while the white work is as sound as ever; the planks that are painted black, will be found split in all directions, while the frequent necessity of caulking a ship in that situation likewise adds

Digitized by Google

to the common destruction; and I am fully persuaded that a piece of wood painted white will be preserved from perishing as long again, if exposed to the weather, as a similar piece painted black, especially in a tropical climate. I have heard many men of considerable experience say that black is good for nothing on wood, as it possesses no body to exclude the weather. This is, indeed, partly the case; but a far greater evil than this attends the use of black paint, which ought entirely to exclude its use on any work out of doors, viz.—its property of absorbing heat. A black unpolished surface is the greatest absorber and radiator of heat known; while a white surface, on the other hand, is a bad absorber and radiator of the same; consequently, black paint is more pernicious to the wood than white. Wood having a black surface will imbibe considerable more heat in the same temperature of climate than if that surface were white; from which circumstance we may easily conclude that the pores of wood of any nature will have a tendency to expand, and rend it in all directions, when exposed under such circumstances; the water of course being admitted, causes a gradual and progressive decay, which must be imperceptibly increasing from every change of weather. The remedy to so great an evil is particularly simple, viz.—by using white instead of black paint, which not only forms a better surface, but is a preventive to the action of heat, and is more impervious to the moisture. The saving of expense would also be immense, and I am convinced that men of practical experience will bear me out in my assertion.

BATTLE OF HYDERABAD IN SCINDE—1843.

Plate 61.

Letter from Brevet Captain R. HENDERSON, *Commanding C Company Sappers and Miners; to the Adjutant Madras Sappers and Miners Bangalore, dated Fort Hyderabad, 20th April,* 1843.

Para. 1. Agreeably to my letter of the 11th Instant, I have the honor to forward, for the information of the Officer Commanding the Corps, the following particulars of the employment of the Company under my Command, connected with the Action of the 24th Ultimo; when Meer Shere Mahomed's Force was completely routed by the Force under the personal Command of Major General Sir Charles Napier K. C. B.

2. On the 22d of March a portion of my Company was ordered out to cut down the Bank of the River Foolaylee on

Digitized by Google

the Hyderabad side, so as to form an easy descent for Artillery. On the evening of the 23d, we formed part of a Force consisting besides, of two Regiments of Native Infantry and a heavy Battery of two 8-inch Howitzers, who were sent forward to take possession of the portion of the bank of the river which we had already prepared; and we remained there during the night. Early in the morning of the 24th this advanced Force crossed the river and we had scarcely formed on the opposite side when Major General Sir Charles Napier appeared at the head of the main body and reserve which had marched out from the Camp at Hyderabad. The whole Force then advanced in order of battle, my Company being at the head of the advance guard, to cut down the banks of nullahs and make the road passable for Artillery. We had proceeded about 3 miles when the General discovered that the Enemy were in position, and moved towards them with the Scinde Irregular Horse. Shortly after this the Enemy opened their fire of Artillery, and the main body was ordered to follow in column the direction taken by the General. The Enemy's cannonade continued during our advance and the British Line took up its first position at about 1200 yards from the Enemy (as shown in the accompanying plan) and within range of their Artillery. Here a bold reconnoissance of the Enemy's position was undertaken by Major Waddington, Commanding Engineer, who rode along their whole front at a distance of about 300 yards. During the advance I received orders to make a slight detour from the column, in order to make a nullah passable for the heavy Battery, and, as it was found that considerable assistance was necessary to bring these guns into action and great expectations were formed as to their effect upon the Enemy, we remained attached to them. At the request of the Officer Commanding the Artillery (Major Lloyd) I ordered the Company to form subdivisions one to each gun—and thus we were enabled not only to give assistance when the Battery was advancing, but also in limbering and unlimbering in action; this operation being a very heavy one and not easily performed by the European gunners of the Battery.

3. When the Troops had formed in the first position, our Artillery opened upon the Enemy; but as the effect of the Shells from the 8-inch Howitzers did not at that distance equal the expectations of the General, he ordered the Line to advance about 500 yards to the second position: the Enemy keeping up a smart fire of Artillery from 11 guns during the whole time.

Digitized by Google

4. From the second Line a heavy cannonade was opened from each of our Batteries, which continued for about an hour. Several of the Enemy's tumbrils of Ammunition were exploded by our Shells, and in one of these explosions the dismembered remains of those who suffered were plainly discernible. Shortly after this there was an evident commotion amongst the Enemy, and a movement towards their right. The General now gave the order for the Infantry to advance. This was done in the most gallant style, and as the line moved by Echellon of Regiments from the left, H. M.'s 22nd was the first to close with the Enemy who were now found to occupy one of the strongest positions that it was possible for an Army to take up—viz. a double canal running along their front, each canal being from 30 to 40 feet wide at top and provided with an embankment on each side—forming in fact a front of two deep ditches and 4 parapets—the ditch and parapet together in many places exceeding 25 feet in height. Besides these, there were other similar canals running in their rear and on their left, whilst their right rested on the village of Narcejah, the exterior walls of which were pierced with loopholes, and in the vicinity were several breastworks newly thrown up.

5. The gallant 22nd Regiment advanced against the most formidable opposition, in the most steady and determined manner. As soon as they were within range the Enemy opened a matchlock fire upon them from behind their Intrenchments; which much resembled the roll of British musquetry. The Regiment suffered under it, but advanced steadily, reserving their fire according to orders till within 40 paces, when they poured in a volley and ascending the first embankment continued their exterminating fire till they were enabled to surmount the formidable obstacles' opposed to them; and then wheeling their right shoulders forward drove the Enemy before them.

6. Meanwhile the 25th and 21st Regiments of Bombay N. I. were advancing in the most gallant manner, under similar opposition, though in a less degree, and, forming on the right of H. M.'s 22d Regiment, these three Regiments drove the Enemy back into the Village, where they were exposed to a heavy fire from the Horse Artillery, which had by this time dashed forward under matchlock fire and brought their guns into position on the top of the first embankment. At last they were obliged to quit the Village, when they were

Digitized by Google

pursued by the Cavalry which completed the route at the right of the Enemy's line.

7. Whilst this was going on towards our left, the right of our Line was also actively engaged. When the commotion and movement of the Enemy towards their right, alluded to in the 4th para. was perceived, and while the Infantry was advancing, it was discovered that some of the Enemy had taken to flight, towards their left. The 3rd Bombay Light Cavalry and Scinde Horse immediately charged in the most gallant manner, and many of the fugitives fell under the sabres of these distinguished Regiments.

8. The other 3 Regiments of Native Infantry (12th, 8th, and 1st Grenadiers) continued their advance and crossed the canals as they came up, but our Cavalry being amongst the Enemy in their front, they were soon compelled to cease firing. Opposition now soon ceased. The Field was our own, and the whole Force after the victory formed Line along the bank of the Foolaylee, as shown in the plan. The last operation of the day was to encamp on the ground in front of the Enemy's position, the front of our Camp being nearly in the same line as the second position of the British Force.

9. With regard to my Company; after the Infantry was ordered to advance, the Artillery could no longer play. I therefore formed the men up, and leaving them under Lieut. Outlaw with the Artillery, I proceeded on and crossed the canals. Lieutenants Outlaw and Boileau soon followed me with the Company, as it was found that the Artillery were not to advance over the canals. But by this time the Enemy began to take to flight in all directions, and as the Artillery were ordered to form Line on the bank of the Foolaylee, we returned to assist the heavy Battery over difficult ground; and after a short halt for the refreshment of the Troops we marched with the rest of the Force to our encampment.

10. In my letter of the 11th Instant, I mentioned the great assistance I received from Lieut. Outlaw and 2d Lieut. Boileau, and the excellent conduct of Jemadar Tonderoyen and all the European and Native Non-commissioned Officers and Privates under my command. I have only to add that Coporal McDonough was wounded in the foot by a matchlock ball and that his bearing on the occasion was very soldier-like.

Digitized by Google

11. On the 25th we halted on the Field of battle, and on the 26th marched to Ali Yar Ka Tanda and thence to Meerpoor, Shere Mahomed's capital, of which we took possession. After this we formed part of a Force sent on to take possession of Oomercote, where some opposition was expected, but the small garrison (25 men) after a short parley came out and laid down their arms before Major Woodburn, 25th Bombay N. I., who commanded. We then entered the Fort (on the 4th of April) in which we found 9 guns. The British Flag was hoisted on the highest Tower, and having left a small garrison in the place, we returned to Hyderabad, where we arrived on the 11th Instant.

12. During a day's halt at Oomercote I was ordered to make a survey of the Fort. A copy of the Plan and Report which accompanied it shall be forwarded to the Officer Commanding the Corps.

Digitized by Google



Digitized by Google

Digitized by Google

ON THE FAMILIAR ANATOMY, OR PROPERTIES AND PROPORTIONS OF THE HORSE.

1. The *head* and *crest* should be considered with reference to the neck which support them.

2 A high crest carries off much of the inconvenience, as well as the unsymmetrical effect of size; still any disproportionate weight (*head*) at the end of the *neck* must interfere with the light carriage forward and safety of a horse intended for the saddle.

3. The junction of the *neck* with the *shoulder* should take place almost on a line with the *withers above*, entering the *chest* about the point of the *shoulder below*.

4. The *windpipe* should be roomy and detached from the underflesh of the *neck*.

5. The *shoulders* without influencing the progressive action of the horse supply *motion* to the *forequarters*, and upon their conformation it depends whether his carriage be light and elastic, or heavy and constrained.

6. The *wear* and *tear* of the animal is thrown on the *forequarters*, and to provide for the shock of exertion the *shoulder* is joined with the body by *muscles* alone.

7. A horse with an *oblique shoulder*, that is, with the *bladebone* slanting well back, possesses the property of projection much in the same ratio, that a horse with a *straight* or *perpendicular* shoulder is without it.

8. The centre of motion by the *scapulla* is in the middle. In the same degree that the *shoulder* is *oblique*, or *perpendicular* will the extention of the muscles (which put it in motion) be increased or decreased.

9. The scapulæ in their movements describe as much of a circle, as their muscles permit.

10. Inasmuch as the *perpendicular and oblique shoulders* differ in their natural position so will they vary in *action*, the latter having the advantage in the faculties of *elevation* and *projection*.

11. The *shoulder* if *overloaded* will want *liberty*. If too lean will be deficient in muscle. Nevertheless *Eclipse* had *beefy withers* almost to a deformity.

12. The *chest* contains the *heart* and *lungs* and should be deep and roomy allowing free action to those important organs, and not narrow or confined.

13. The *forelegs* should fall perpendicular from *shoulder to foot* not inclining under the animal, otherwise his action will be faulty.

Digitized by Google

14. The uniformity with which a horse's foot finds the centre of gravity (sets his feet on the ground) is one of the surest tests of safety as a roadster.

15. If the *elbow* be turned *in or out*, the result will be *dishing* of the legs, and consequent unsafety of action.

16. The *pasterns* should be moderately *lengthy* and *oblique, an* upright pastern is deficient in elasticity and *prone* to produce contraction of feet by throwing the weight on the *toe*, and not on the *heel*.

17. The *foot* should be put flat to the ground and if the shoes are unevenly worn, be sure the action is neither firm nor secure.

18. Want of *power below the knee* is of little consequence; all the *levers* exist near the *shoulder*, there let it exhibit muscular force.

19. Due obliquity and muscularity of shoulder must produce good and liberal action.

1st. Below the knee the appearance to the eye should be that of a flat surface exhibiting nothing but *bone* and *tendon*. Any *rotundity* proclaims *disease*.

2d. The *tendons* should stand out boldly and clear of the bone.

3d. A *broad flat knee* is favourable to the freedom of that joint.

20. Never place a horse to look at on a *surface sloping* from the *fore* to the *hind quarters*. Let him stand *horizontal* and observe whether his *shape* accommodates itself to the *straight line*.

21. The *stifle* and *elbow* should be on a line to secure conformity of *motion*, which will give to every portion of the animal machinery equality of labour.

22. A good *barrel* or *middle piece* is essential to excellence, being the *mainspring* which connects the two points of action.

23. It has been observed that a *chest* should be roomy and deep to allow free action to the heart and lungs. *Well arched ribs* are great auxiliaries, giving facility of breathing in *fast work*, where *wind* is in a great measure *strength*, or at all events the *quality* without which *muscular power* is useless. A *flat sided* horse, from a greater pressure of the atmosphere, has less facility of breathing.

24. Select a horse short in his carcase, close-ribbed up. Horses are *not therefore always slow*. The *trunk* has nothing to do with motion.

25. With *shortness of back* is generally *width of loin*. These are the points which give power to carry *weight* and to endure prolonged exertion.

Digitized by Google

26. Where *length* in a horse is produced by a *width* of *shoulder* and *quarter* it is so much added to power; where *length* proceeds from space between *ribs* and *hipbone* it is so much taken from it.

27. The *back* should fall gracefully in a slight degree from the *withers* then straight to the *loins*, and so gradually to the *tail*, affording only sufficient room for the *saddle*.

28. The *hind quarters* are the great moving principle of the machine. This is indicated by the *angular form* of the *thigh bones*, and *powerful muscles* with which they are furnished.

29. The *source of motion* is no longer believed to exist in the *forequarters*.

30. The *hind quarters* are powerfully connected with the frame by *joints* of extraordinary strength, and are destined to propel the animal forward, whereas the *forequarters* are attached to it by *muscles merely*, and only sustains the *equilibrium*.

31. The gaskins are the most essential features of the hind quarter. *Inside* they should curve from the *stifle* down to the *hock*. *Outside* a great *prominence of muscle* should be developed.

32. *Length of thigh*, and *angularity of hock* are points which indicate *speed* and *activity*, in the ratio in which they exist.

33. The *hind legs* of a hare are thus constructed, an animal of unequalled speed, if we compare *her velocity* with the *space* she is fitted to *cover* at a *stride*.

34. To be "a good judge" it requires that the eye should be accustomed to the *general anatomy of* the animal, and be able thereby to detect at once *all the ordinary points*. A much closer scrutiny is necessary to avoid all the dangers concomitant on the purchase of horse flesh.

35. "A perfect horse, like a perfect man, is a faultless monster that the world ne'er saw."

Digitized by Google

MINING OPERATIONS NEAR DOVER.

Letter from Major General PASLEY, *to the Editor of the Times Newspaper, 17th April*, 1843.

Having had frequent questions put to me in conversation respecting the great explosions near Dover, by which Round-down Cliff, an immense projecting mass of chalk in the proposed line of the South-Eastern Railway, was thrown down, I request your insertion of the following statement, in order to correct several inaccuracies in my own letter to you of the 23d of January last, which I wrote in haste, that it might appear in time to remove the impression which I found generally prevailed, that the whole operation was under my direction, but which I considered only a vague report, until I saw it quoted from an article in the *Railway Times*; which quotation did not come to my knowledge until three days before the time appointed for the firing of those great mines.

To Mr. W. Cubitt, the engineer in chief of the South-Eastern Railway, is justly due the merit of having conceived the idea of removing a mass of chalk rock, nearly 300 feet in length, but of still greater height, and averaging 70 feet in thickness, by simultaneous explosions of gunpowder, instead of employing labourers to scarp it away, which would probably have cost nearly 8,000*l.*, and the merit of success also belongs to him, inasmuch as he took the most judicious measures to insure it; but, as he informed me that he never would have contradicted the reports which ascribed the entire superintendence of that great operation to me, and as he is not likely to publish anything on the subject, I am desirous not only of correcting the inaccuracies in my first letter to you, but also of supplying the omissions in the printed accounts, by noticing the useful labours of those who contributed to his success, which I have always made a point of doing, in every similar operation that has taken place under my own direction, and which, I am sure, that Mr. Cubitt would do if he wrote himself, as I know from the able resident and assistant engineers of the same railway, that instead of assuming the whole merit of the works in which they have been employed under him, he has always been ready to acknowledge their services in the most liberal manner, both officially to the directors of the company and personally in conversation, as I have witnessed myself.

The general impression, that the mines near Dover were to be superintended by me, no doubt arose from its being known that Mr. Cubitt always intended to consult me, and that he

Digitized by Google

would not, and did not, decide upon his plan of operation until after he had taken my opinion; and it was also known that he relied entirely upon my assistance for firing his mines simultaneously by the voltaic battery, of the use of which, as applied to mining, neither he nor his assistants had had any practical experience. Accordingly I went to Dover by his request, and introduced Lieutenant Hutchinson of the Royal Engineers, who had been employed two summers under me in the operations against the wreck of the Royal George, and who happened, fortunately, to be on duty at that place at the time, so that I recommended him as the most proper person to superintend the firing of the proposed mines by the voltaic battery, provided that the permission of the Master-General of the Ordnance could be obtained to enable him to undertake this service, which was readily granted, on application being made to Sir George Murray by the railway company. Accompanied by this officer, I examined the drawings of Rounddown Cliff, that had been prepared under the superintendence of Mr. John Wright, the resident engineer of this portion of the railway, to whom Mr. Cubitt referred me on the 10th of November last, and went with him into a drift, or small gallery, cut entirely through the cliff, and about 248 feet in length, which had originally been intended for the commencement of a tunnel through which the railway was to pass; a design that was abandoned afterwards on discovering that this part of the cliff was likely to give way sooner or later, and the plan of removing it by gunpowder was adopted in consequence. Shafts about 17 feet deep had been sunk from this gallery, and branches driven from the bottom of them further into the chalk, in order to obtain greater lines of least resistance, on the level of what would have been the bottom of the proposed tunnel, and agreeing with the position of the rails. Mr. Cubitt had previously told me, that his rule for estimating the quantity of gunpowder for explosions in chalk was to use half an ounce for each foot of the cubed line of least resistance. As he talked of having charges of from 5,000lb. to 6,000lb. or 7000lb., I could not but be surprised at this unusual mode of estimating such very large charges by halves of ounces; but, on going to the spot, Mr. Wright explained the mystery by informing me, that he had, by Mr. Cubitt's direction, fired four experimental mines in the course of the year, in which, having had no previous personal experience, he adopted the rule laid down by Major General Sir John Burgoyne, formerly of the Royal Engineers, and now President of the Board of Public Works in Ireland, for blasting in hard rock, which as the line of least resistance in

Digitized by Google

rock seldom exceeds a few feet, it was more convenient to determine in parts of an ounce than in pounds: and he also adopted Sir John Burgoyne's recommendation in his printed paper on blasting, by firing those mines with Bickford's fuzes, which is an excellent expedient for blasts in rock, and inferior only to the voltaic battery, but such as I never would have used for mining. For example, Mr. Wright's first experimental mine, fired on the 5th of March, 1842, had a line of least resistance of 25 feet, was loaded with 500lb. of powder, had a tamping of 50 feet, and was fired with 100 feet of Bickford's fuzes in two lengths. His three other mines, the largest of which had a charge of 1,100lb., were each fired by 50 feet of Bickford's fuze. It is difficult to conceive anything more tantalising than these arrangements must have been, for I calculated that 100 feet of Bickford's fuse would burn nearly an hour, and that 50 feet of the same would burn nearly half an hour, before the explosion took place. Nothing can be more teasing than such suspense. Our practice in the Royal Engineers, before we began to use the voltaic battery, was very different, as we never allowed a greater interval between the lighting of the portfire or fuze and the ignition of the charge than from one to two minutes, being just enough to allow time for the officer or non-commissioned officer who fired the mine to retire to a distance sufficient for his personal safety. In all his experimental mines, which were fired singly, and independent of each other, Mr. Wright found, that the rule deduced by Sir John Burgoyne with great care and skill from numerous experiments tried by his direction, in order to ascertain the proper charges for blasts in hard rock, which had heretofore been left to the discretion of the miners or quarrymen, and which in practice seldom exceed a few ounces, were equally appropriate for mining in solid chalk, in which the charges, calculated according to the above rule, produced moderate demolition, without throwing the fragments to a distance, an object always desirable, except in military mines, having not merely demolition, but destruction in view. After having had this matter explained, I again inspected the plans and sections of Rounddown Cliff, and, considering the length of the gallery and the proposed lines of least resistance, two of which were to be about 56 feet, I was of opinion from my own repeated experience in conjunct mines, which had not as yet been attempted by the engineers of the South-Eastern Railway, that two mines only, with charges calculated to effect moderate demolition, could not possibly throw down the whole of the cliff. I therefore approved of three charges, to be placed at equal distances from

Digitized by Google

each other, but the two extreme charges to be nearer to the ends of the gallery than to the intermediate charge in the centre of it; and as I thought that Sir John Burgoyne's formula must be calculated rather for very moderate, than for moderate demolition, I was of opinion that the distances between the three charges should be somewhat less than two-lined intervals, which our own experiments on conjunct mines had established as the most proper for moderate demolition. In case of using three charges, Mr. Wright informed me, that whilst the line of least resistance of each of the two extreme mines would be 56 feet, that of an intermediate mine between these two would be about 62 feet, which lines required two charges of about 5,500lb., and one of about 7,500lb., if calculated according to the above formula, without reference to their distances apart. This last point had not yet come under the consideration of the engineers of the South-Eastern Railway, who had only fired single and independent mines, as was before observed.

On giving my opinion first to Mr. Wright, and to Mr. Hodges, his assistant, and afterwards to Mr. Cubitt, the atter objected, and as I admitted on good grounds, to the extreme mines being moved nearer to the ends of the gallery, allthough this arrangement had been adopted by me with perfect success in all my conjunct mines, because he apprehended that this would cause the fragments from those two mines to be thrown out laterally on each side of the Round-down Cliff, in the direction of the gallery, prolonged so as to obstruct the proposed line of railway, more than if the whole were projected forward towards the sea. At the time when this conference took place, I did not know how many mines were prepared, as I had only gone down one shaft, and into one chamber to examine, but did not walk through the whole of the gallery, so that the impression upon my mind was that three chambers were then in readiness for the intended explosions, which was confirmed by my afterwards hearing that three charges corresponding with the lines of resistance then mentioned to me, had actually been adopted, and therefore, when I wrote to you on the 23d of January, it was natural for me to believe, not only that every arrangement had then been previously fixed by Mr. Cubitt, subject to my approval, but that all the three chambers, were actually ready for receiving the gunpowder, and only waited for the voltaic apparatus, which had all to be made, as I recommended, in preference to borrowing.

I have since been informed by Lieutenant Hutchinson, that I was so far mistaken, that only two chambers were pre-

Digitized by Google

pared at that time, so that the third shaft, with the branch and chamber leading from it, were excavated subsequently to my visit to Dover, and also that the position of one of the first two chambers was altered after the same period. Eventually the three chambers were placed at only 70 feet apart thus dividing the length of the gallery into four equal parts but the line of least resistance of the central chamber, on placing them all in the same allignment, proved to be 72 feet, which would have required a charge of nearly 11,700lb. according to Sir J. Burgoyne's formula, and yet the original quantity of powder calculated for 62 feet was not altered. These arrangements were thus definitively made, not before, but after my visit to Dover, at the suggestion of Lieutenant Hutchinson, after he (by permission of Sir G. Murray) had been placed in charge of the proposed mines; and were very judicious, because the chambers being only 70 feet apart were at much less than two-lined intervals, even in reference to the shortest of the lines of least resistance (56 feet) above mentioned; and in this case, if the central charge had been estimated according to the same formula as the others, violent demolition would have been produced, which was not desirable. In short, the same rule invariably adopted by us in the Royal Engineer department, in respect to conjunct mines, was here followed—namely, to diminish the regular charges, which are known to be capable of effecting moderate demolition, whenever they are placed at much less than two-lined intervals apart. Though this term is very generally understood, yet perhaps it may not be superfluous here to explain that in speaking of conjunct mines, the term "two-lined intervals" implies that the central distance between adjacent charges is twice the line of least resistance of each, the latter being the distance from the charge to the nearest surface of the rock or mass that is to be removed by the explosion.

The whole of the arrangements for firing these great charges by the voltaic battery were made by Lieutenant Hutchinson, assisted by Lance Corporal John Rae and Private Thomas Smith, of the Royal Sappers and Miners, and by two Naval pensioners, John Leary, a blacksmith, capable also of working in tin or copper, and William Gordon, a rigger, all of whom had been employed under the same officer at Spithead, and who in their several capacities understood thoroughly every thing relating to the preparation of charges and to the mode of firing them by the voltaic battery. Leary, who is an excellent workman, and who distinguished himself some years ago whilst under the command of Captain Dickenson of the Royal Navy, by converting ships' tanks into a

Digitized by Google

diving-bell, by means of which that enterprising and intelligent officer recovered the treasure sunk in the *Thetis* frigate on the coast of Brazil, was employed on his arrival at Dover in making voltaic batteries for the proposed explosions, nine in number, each consisting of six cells of Professor Daniell's constant battery, such as had been used by me in all my mining operations, and he also put together the wires for three conducting apparatuses, each 1,000 feet in length, and consequently composed of 6,000 feet of copper wire. Each apparatus consisted of a pair of wires attached to a strong rope, and secured and insulated by Pensioner Gordon in the same substantial manner that had been adopted by us at Spithead, for though there was very little necessity for guarding against the action of water, yet the letting it down and dragging it up the high chalk cliffs exposed this apparatus to a good deal of wear and tear; and it might also have been injured by the hob-nailed shoes of railway labourers to which it was continually exposed, as I observed particularly on the day it was used, when every person that came near it trod upon it, and which, had it not been thus protected, might have destroyed the connexion and prevented the explosion, of which I have known instances in the course of our former experiments. As soon as the batteries and conducting apparatus were complete, Lieutenant Hutchinson tried experiments to ascertain whether he could fire all the three charges simultaneously by one powerful battery, as had been done by Dr. Hare, of Philadelphia, who first applied voltaic electricity to practical purposes, by using it for blasts in rocks to obtain stone for building in 1831, as minutely described in Silliman's *American Journal of Science*, vol. xxvi., page 352, and also briefly noticed in the transactions of the British Association for the advancement of Science, held in Bristol in 1836. From his own experiments, tried with this object, Lieutenant Hutchinson drew the same inference that I had done about three years before,—namely, that one cannot depend upon more than two charges exploding simultaneously, for though by a battery of extraordinary power he succeeded in firing 12 small experimental charges at the distance proposed for the great mines under his direction, yet there was a perceptible interval of time between the reports, which resembled a volley of musketry rather than the discharge of a single gun. He therefore determined to adopt the plan which I had proposed to use in 1839, had it proved advisable to fire four subaqueous charges simultaneously against the wreck of the Royal George, namely, to have a separate voltaic battery for every charge, and a person at each, with one conducting wire fixed to a

Digitized by Google

pole of the battery, and the other in his hand ready to complete the circuit, according to the time marked by the chief, who was to give the words—*one*—*two*—*three*—with an interval of about one second between each, and then the word *fire*, which was to be the signal for completing the circuit; and by this mode I expected that the explosions would all take place simultaneously, on the principle of marking time in music. The powder in each of the three chambers prepared for the several mines at Dover was contained in bags, placed in a large box, the former expedient having first been adopted in the practice of the Royal Engineers at Chatham; but we never used box and bags also, which I considered superfluous. As these boxes formed what may be called double cubes, Lieutenant Hutchinson very judiciously had a couple of short branches forking out from the lower extremity of each conducting apparatus into two central points of the oblong charge. Very short and fine pieces of platina wire were placed, according to custom, near the closed ends of strong tin tubes fixed to the outside, and leading into the centre of the powder-boxes, in which tubes bursting charges of fine-powder were introduced, surrounding the platina wires, on the same principle that had been used at Spithead, but without those extreme precautions that had been found necessary to resist the great pressure of water to which our charges there were subject.

In the course of Lieutenant Hutchinson's experiments an unforseen difficulty occurred, owing to Daniell's batteries, which had been very promising, losing their power after the first frosts set in. This difficulty had never embarrassed us before, because in our experiments at Chatham we always took the battery out of a warm room, and it required a longer time to impair its power than our experiments there ever occupied; and at Spithead, where Lieutenant Hutchinson first used the battery, it was generally kept in the cabin of one of our lighters; besides which the work was only carried on during the summer months. He was therefore obliged to have a small wooden shed built for his batteries at Dover, and to keep fires lighted whilst using them, by which he got rid of the difficulty.

I have since been informed, that in experiments tried at Calcutta, a very energetic battery lost half its power when the temperature fell from 120 to 60 degrees of Fahrenheit. When this difficulty occurred, a prejudice was naturally excited against Daniell's battery, and four very powerful plate batteries were ordered at Dover in consequence, which were made by an intelligent tradesman of that town. The trough

Digitized by Google

of each of these contained 20 cells, according to Dr. Woolaston's construction, with zinc and copper plates, measuring 7 by 10 inches, the latter of which only were let down into the trough when the battery was about to be used; and these plate batteries were combined with the batteries made by Pensioner Leary as before mentioned, so that one very powerful battery, consisting of 40 plates of the common system, and of 18 cells of Daniell's constant battery, was to be used for each of the three great charges. But here I must remark upon a great inaccuracy in my letter to you of the 23d of January last, in which I stated that the length of conducting wires about to be used at Dover was far greater than had ever been used by me either at Chatham or at Spithead, instead of which the contrary was the fact; for on referring back to the journal of our experiments at Chatham, I find that we fired an experimental charge on the 7th of July, 1839, at the distance of 1,950 feet, by 14 cells only of Daniell's constant battery, as recorded in the *United Service Magazine* for January, 1840, being more than twice the distance at which the great mines at Dover were afterwards fired by batteries of three times that magnitude, and at a temperature which could not have been less than that of our experiment. I said twice the distance, because the conducting apparatus for the charges at Rounddown Cliff, originally each 1,000 feet long, were afterwards reduced to less than 900, their former length being unnecessarily great. I thought it right to rectify this error, lest a prejudice should be excited against Daniell's constant battery by its supposed inferiority, which led to the employment of plate batteries at Dover, in addition to those of his pattern, which were first made. At the same time, I am now of opinion that the plate battery is the most convenient of the two for firing gunpowder, and the simplest that I have seen is that which is now being used by Mr. R. Davidson, of Aberdeen, in his interesting exhibition of electro-magnetic power at the Egyptian-hall, Piccadilly, which I visited lately in company with Dr. Faraday and Mr. Brande. This battery, which contains 20 cells, differs from Dr. Woolaston's in using amalgamated zinc, and in substituting plates of iron instead of copper, all the plates measuring 8 by 11 inches, and the action being produced by diluted sulphuric acid, upon the purity of which, Mr. Davidson says, the efficiency of his battery chiefly depends. On inquiring who first adopted iron plates instead of copper, Mr. Davidson assured me that he had used the former metal himself for about 20 years, but that the merit of this arrangement was disputed by Mr. Sturgeon and Mr. J. Martyn Roberts, with

Digitized by Google

whom he himself had not thought proper to contest it. Dr. Faraday observed, that articles published in any public or scientific journal afforded the only genuine grounds for deciding upon priority of inventions, for the same idea might occur to several persons, and the individual who worked in private must give way to those who published. On this plea, I advise those who ascribe the merit of applying the voltaic battery to the purposes of blasting in earth or rock, or the peculiar construction and management of the first plate battery, well calculated for this purpose, to any of our own countrymen, to refer to the documents before quoted, and they will find that they are doing an injustice to Dr. Hare, of Philadelphia. But it must not be forgotten, that Mr. William Snow Harris, of Plymouth, was prior even to Dr. Hare, having fired gunpowder by electricity in March, 1823, which he effected to the astonishment of numerous spectators by a common electrical machine, from the cabin of a small vessel at anchor in that port, whilst the charge was placed in another at a considerable distance, and separated from the former by the water, through which his conducting apparatus passed. But the electrical machine, though perfectly efficient, never would have superseded the common modes of firing mines, as the voltaic battery has done, because the former not only requires a much more delicate manipulation than could be expected either from civil or military miners, and would be more easily broken or deranged ; but it also requires artificial heat at all times, even in summer; whereas the voltaic battery can always dispense with this very inconvenient arrangement, even in the depth of winter, excepting in the case of very long exposure to a low temperature, which can seldom occur.

To return from this digression to the mines near Dover. By the 26th of January, the day appointed for the explosion, all the great charges had been placed in their respective chambers, with the two small bursting charges in the centre of each. whilst the conducting apparatus were led thence, two out of the east, and one out of the west end of the gallery, to the summit of the cliff, about 300 yards beyond the edge of which they were united with their respective batteries. These were placed alongside of one another in the shed beforementioned, in which powerful charcoal fires were kept burning, one near each battery. The mines had been tamped by filling up the branches and shafts, and 10 feet of gallery on each side of the shafts with rammed chalk, but leaving a vacant space of several cubic feet at each chamber, which had not usually been done by me, as my first experiments left me in doubt whether any advantage was obtained from this arrangement. Before

Digitized by Google

the hour appointed for the explosion, the three voltaic batteries, each consisting as beforementioned of 40 sets of Woolaston plates and 18 of Daniell's, had been got ready by Lieutenant Hutchinson, assisted by Lance Corporal Rae and Private Smith, who had been specially employed under him all last summer, in preparing and firing the numerous subaqueous explosions at Spithead. Mr. Wright and Mr. Hodges, who had been present at, and assisted Lieutenant Hutchinson in, his preliminary experiments, were now each stationed at one battery in readiness, whilst that officer himself took post at the third, to give the word of command.

The position of the spectators, and the signals for firing, &c, have been so well described by your own reporter, as well as by Sir John Herschell, in the *Athenæum*, and in other papers of the day, that I shall only remark that considerable anxiety was caused by the unexpectedly long intervals that elapsed between the first and second signals, which led the spectators to apprehend that something had gone wrong or been forgotten. At last, the second signal was made, and the third signal for firing followed at the appointed interval. At this moment the lower part of the cliff was seen to swell or bulge out, immediately after which the top of it descended gradually, whilst the bottom also was put in motion, and flowed slowly towards and into the sea, and spreading out at the same time to more than its original width; and as it approached and filled up part of the water, a black margin was observed issuing from the extreme outline of this extraordinary stream of white chalk, which was at the time apparently in a fluid state. No smoke was perceived anywhere, unless the dark border, of which no trace remained afterwards, was such. I neither heard a report nor felt a shock myself, nor had I anticipated any, from the small quantities of powder used, that is, comparatively small, in reference to the depth at which the charges were buried; but the former was perceptible to many of the spectators of more acute hearing, and the latter was felt also, and described as a slight tremulous motion of the earth by some of them. It was particularly noticed by those who were seated on the ground near me, at a high point of the cliff to the westward which commanded a flanking view of Rounddown. I would have preferred standing much nearer, and indeed a person at the distance of 50 yards from the edge of Rounddown Cliff itself would have been perfectly safe, but it was impossible to have a good view except from a distance. Lieutenant Hutchinson and his assistants lost the sight, and as they felt no shock and heard no explosion, they were not without some apprehension that their mines had

Digitized by Google

failed, until they rushed out of the battery-house, and heard the repeated cheers of the delighted spectators, amongst whom the hardy railway labourers, who are chiefly men of Kent, were not the least vociferous. The cause of the delay between the first and second signals was now explained to me by Lieutenant Hutchinson. One of the three batteries, when tested by the voltameter, proved inactive, and, therefore, there was reason to fear that the conducting apparatus of one charge might have been deranged. But on a closer investigation, it was found that a zinc rod in one of Daniell's batteries had broke by some accident, at which I was less surprised, because I had previously remarked on the very bad qaulity of the zinc supplied from London of which these rods had been made. On discovering this defect, that battery consisting of 6 cells, wss set aside, and the connexion was made by the remaining 12, combined, as before stated, with 40 sets of Woolaston plates, a power of battery even then far exceeding what was absolutely necessary; but it is best on great occasions to employ a superfluity of power, as I myself have always done.

Soon after the sort of volcanic movement caused by the explosion had come to an end, we observed from the top a great number of spectators, who had stood below at a respectful distance from the foot of the cliff, but who now ran and spread themselves over the masses of chalk that had been moved towards the sea, and covered a large space of ground. These persons appeared like pigmies from the high and distant point whence we viewed them, and the moving stream of chalk which flowed towards the sea when seen from the same point had previously appeared as if it had been crumbled into white powder, for no part of it seemed larger than the usual size of beach shingle, and the inequalities on its surface were imperceptible; but on descending the cliff and examining the *debris*, we were surprised to find that they consisted of large irregular fragments of all sizes, some of which must have weighed more than a ton, and which were heaped up or packed in some places to the height of about 30 feet, but more spread out in others.

Here and there we found fragments of earth and grass that had originally covered the top of the cliff, lying upon those rugged masses of chalk below, which when seen from above had appeared like dark brown spots on a white ground. As it was extremely troublesome and fatiguing to walk over the *debris*, for the smaller lumps of chalk rolled under the foot, and the larger ones could not be ascended or passed without an effort, several persons went down to the beach in order to

Digitized by Google

go entirely round them, it being then low water, in which they afforded some merriment by sinking up to their middle, or falling down in crossing some little quagmires of very fine chalk and mud, with small temporary streams flowing through them from the bottom of those great masses, which had prevented the whole of the water of which they took the place from escaping quickly as the tide fell. A flagstaff had been placed at the summit of the cliff before the explosion, which was found prostrate, but uninjured, at some distance from the bottom of it, and was set up again with a flag of the same colour, on the spot, by the railway labourers. I observed a considerable portion of the voltaic conducting apparatus, which had also been thrown down; when afterwards collected and opened, for very little of it was lost, the copper wires were found to be much injured by the kinks occasioned in its fall, but externally it had appeared perfect. That the ruins of the chalk cliff thrown down by this great explosion should have covered 15 acres of ground, may appear surprising, or even incredible to many, as, from recollection, it did to me until I was assured that an accurate survey of it had been made by Mr. Hodges, of which such was the result. The new face of the cliff produced by these great mines was nearly parallel to the original slope, but of a more regular form, being nearly a plane surface, except at the bottom, where a proportion of small chalk rubbish brought down by the explosion is piled, at a greater slope, against that which still remains solid.

Gratified as they could not fail to be, by the splendid results of an operation, that probably did not save less than 7,000*l.*, the chairman and directors of the South Eastern Railway Company addressed a letter of thanks to the Master-General and Board of Ordnance, on the 16th of February, "for having "allowed Lieutenant Hutchinson, of the Royal Engineers, "assisted by Lance Corporal Rae and Private Smith, to make "the arrangements for, and superintend the firing of the great "mines at Dover, on the 26th of January, by which the entire "removal of Rounddown Cliff was completely effected;" and further observing, "that the important operation referred to, "having been accomplished by the voltaic battery with a degree "of skill as gratifying to the directors of the company, as cre-"ditable to the talents of Lieutenant Hutchinson and those "acting under his directions, they solicited the permission of "the Master-General and Board, that Lieutenant Hutchinson "might be allowed to receive from the company a piece of "plate, which the directors were desirous of presenting him "with, in token of the high estimation in which his valuable

Digitized by Google

" services on the memorable occasion referred to were held by " them."

This proposition having been acceded to by the Master-General and Board, " as a special case," for it is contrary to etiquette that the services rendered by an officer of the army should be noticed by any mark of approbation except by his own superiors, if performed as a part of his military duty, or by their permission, if otherwise,—as soon as this was communicated to them through Mr. Byham, the sum of fifty guineas was expended by the Chairman and Directors of the South-Eastern Railway Company in this testimonial of their gratitude to Lieutenant Hutchinson.

Finding the immense benefit of this great explosion, Mr. Wright and Mr. Hodges, by the approbation of their chief, have since fired several other mines with equal success in the same range of chalk cliffs by the voltaic battery. of which they acquired a thorough knowledge, as well as of the general principle by which conjunct mines ought to be regulated, whilst under Lieutenant Hutchinson—viz., two mines of 750lb. each on the 10th, and two of 900lb. each on the 14th of February; after which, on the 2d of March, they fired eight conjunct mines, all in the same line, in which they expended 6,440lb. of gunpowder, along a range of cliff of such very irregular outline that they varied their charges from 200lb. to 2,000lb. Mr. Hodges has contrived a simple and ingenious apparatus for completing the circuit of several voltaic batteries at the same moment by one operator: and they propose to fire more than 12,000lb. of powder, distributed amongst 15 or 16 conjunct mines, in order to remove another portion of the same cliff, on the 18th instant. In short, these gentlemen, who had no knowledge of this art a year ago, have profited so well by their opportunities that I consider them capable of planning and executing any mining operation, however extensive, with skill and success. In respect to conjunct mines calculated for a scale of moderate demolition, I shall here remark, that it is not absolutely necessary that they should all explode at the same moment of time (which is difficult even by the voltaic battery, but by all the former methods of firing gunpowder absolutely impossible, though the contrary has been asserted by writers copying from the old French authors on military mining. For example, in the course of our experiments at Chatham, before we knew the use of the voltaic battery, we first demolished a brick wall about four feet thick by blasts fired successively by a very small powder hose leading along the back of the wall, and connected with each charge, one end only

Digitized by Google

of which hose was ignited. In like manner Lieutenant, now Captain James, of the Royal Engineers, acting under my direction, demolished 466 feet in length of the brick revetments or retaining walls of an entire front of the old fort of Sheerness, with the exception of one of its flanks, but including its ravelin, with such complete success, on the 14th of July, 1827, that the brickwork was as it were just turned over nearly on the same spot, but crumbling into pieces as it fell, without any of the fragments being thrown to a distance, although no two of the explosions were simultaneous. In this operation 15 charges, generally of 84lb., but some of 90lb. in barrels, were used against the demibastion and curtain, whilst 23 charges of 25lb. each, placed in bags, were used against the ravelin. The former were grouped by twos or threes as conjunct mines; the latter were all fired one after another, at intervals of several seconds of time, by igniting one end of a longitudinal hose laid along the top of the wall, and communicating with separate vertical hoses leading down into the several charges. But though simultaneous explosion is thus evidently unnecessary in conjunct mines having their charges calculated to effect moderate demolition, yet in the case of violent demolition absolute precision is indispensable, otherwise the explosion of the first charge may derange the others, and either diminish the general effect of the whole, or even cause some of them to fail altogether, of which I have known instances.

The great explosions which took place at Dover on the 26th of January last are certainly the triumph of the art of mining in this country, but the British military engineers, by whom undoubtedly it has been brought to perfection, were not so fortunate in their first attempts, as the able civil engineers of the South-Eastern Railway. Owing to the inefficient state of the Royal Engineer Department at the commencement of the present century, which was not improved until towards the close of the Peninsular war, the officers had no opportunities of acquiring practical knowledge in this important art. Hence in Sir John Moore's retreat, all the mines of demolition made for the destruction of the bridges in our rear failed, excepting one, in which Lieutenant Davy, a most promising young officer, blew himself up along with the bridge that he destroyed; and I myself was one of the unsuccessful operators in that campaign, in an undertaking in which no non-commissioned officer and very few privates of the corps would now fail. At the siege of Badajoz, Captain

Digitized by Google

Stanway, a most gallant and intelligent engineer officer, succeeded in placing a charge to blow up a dam that retained an inundation, which was a great impediment to the besiegers, but the explosion failed, from the mode of securing charges against the pressure of water not being then understood ; and in the attack of Burgos the work of the British miners was obliged to be suspended from time to time for want of air, because the simple method of ventilating military mines was not known. Towards the close of the Peninsular war, however, the distinguished engineer officers employed in it had acquired more experience, and none of their mines of demolition against bridges, &c., failed as at first.

In India, where the same defects prevailed, perhaps to a still greater extent, the first mining operations after the commencement of the present century were not merely unsuccessful, but calamitous, for at the siege of Cumoona, an insignificant little mud fort, in 1807, the company's engineer officer, whilst preparing mines to throw down the enemy's counterscarp, was himself blown up in his own gallery by the native miners opposed to him, and our troops were afterwards repulsed with great slaughter in an attempt to storm the place, which, however, was afterwards evacuated in the night. About two years before, in the first siege of Bhurtpore by Lord Lake, the repeated assaults ordered by that gallant General had been repulsed, chiefly by explosions of gunpowder prepared in the ditch. More recently, the East India Company's engineers have everywhere distinguished themselves by their superior skill in mining, especially at the second siege of Bhurtpore in 1826, though the native miners there had lost nothing of their former energy, for they actually penetrated into one of our galleries, where a combat took place, in which a captain of the Engineers was wounded. Their efforts were, however, unavailing, for the Company's Engineers opened the way for our storming parties into that supposed invincible fortress by two great mines, one of which not only effected a broad and practicable breach, like the other, but levelled in the dust a large circular bastion, on which 300 or 400 of the enemy's bravest troops were posted, who were all destroyed by the explosion. I need scarcely mention that the East India Company's Engineers performed the same important service in Lord Keane's attack of Ghuznee in 1839. Failures on either of those occasions, such as had previously occurred after the beginning of the present century, would have shaken our Indian empire to its centre. In Europe and America, where the Royal Engineers only are

Digitized by Google

employed, mining has not been required in any of our military operations subsequently to the close of the Peninsular war, so that they have not had the same opportunities of establishing their character for skill in mining, which their friends and cotemporaries of the same branch of service in India have enjoyed.

If my first letter, which appeared in your columns of the 24th of January last, had not been full of inaccuracies. I would not have troubled you either with the above account of the great mines at Dover, or with the observations on the progress of the art of mining in the British service, into which I was led in the course of my narrative, for the length of which I beg to apologize.

Digitized by Google

Digitized by Google

CARE AND MANAGEMENT OF CAMELS.

Letter No. 2888, *from Lieutenant Colonel* P. M. MELVIL, *Secretary to the Bombay Government, Military Department, to the Secretary to Government, Fort Saint George, dated Bombay Castle, 3d September* 1842.

I am directed by the Honorable the Governor in Council to transmit for the information of the Right Honorable the Governor in Council at Fort Saint George, the accompanying Extract, Para. 5, of a Despatch from the Honorable the Court of Directors No. 30, dated 29th June last, together with copy of the Regulations for the care and management of Camels, therein alluded.

Extract Para. 5, *of a letter from the Honorable the Court of Directors, No.* 30, *dated 29th June* 1842.

Owing to the severe loss of Camels on the march of the 25th Native Infantry, from Moortung to Khelat, certain rules drawn up by Brigadier England for the purpose of introducing a more careful supervision, have been sanctioned with the concurrence of the Commander-in-Chief.

Para. 5th. We observe with satisfaction the care bestowed by Brigadier England in framing a Code of Regulations for the care and management of Camels, regulations which, as remarked by you, appear to be judicious and well calculated to preserve the efficiency of Field Forces in this important branch—you will communicate these rules to the Government of Bengal and Madras.

Regulations by Brigadier ENGLAND *for the care of Camels, dated Camp near Quetta,* 1*st July* 1841.

The following regulations, as to the care and management of Camels, are to be enforced by Officers Commanding Corps and Heads of Departments in the Scinde Force.

1st. In Corps, Orderly Officers on daily Regimental duty, are to be directed to include the care of the Regimental Camels in their routine, and are to be present at their evening feeding.

2nd. The Quarter Masters of Corps are to consider the supervision of all the Regimental Camels as part of their duty.

3rd. A Camel Serjeant or Havildar from each Corps is especially appointed to supervise every detail connected with

Digitized by Google

the Camel Department within their respective Corps, and to be exempted from all other duty.

4th. A Camel Corporal or Naigue, per Troop or Company, is to be named in the Regimental Orders to assist the Serjeants—and these Corporals are to be exempted *from the duties of Guard and Picquet.*

5th. The Camel Serjeants will attend and see that the Camels when not on the march, are taken to graze every morning at 7 o'clock, and they are responsible that a proper proportion of Camelmen go out with them with knives, to cut forage for the use of the Camels at night.

6th. When on the march the Serjeants will receive orders on this subject from the Commanding Officers, and they are to instruct the Jemadars and others who go out with the Camels, to keep within protection of the evening parties, should the latter be necessary.

7th. The Camel Serjeants are also to instruct the Jemadars and Camelmen as to their proper time of returning to Camp, and in the evening they are to inspect the quantity of Forage which has been cut and brought back, causing those Jemadars who have been neglectful in this matter to be punished by fine or otherwise.

8th. The Camel Serjeants are invariably to be present at the evening feeding, together with the Corporals of Companies, previous to which the Camels are to have their saddles taken off and their backs inspected ; if there are sore backs, the proper remedies are to be immediately applied, and the cause of the injury rectified by having the saddle altered or mended. Saddles must be put on at night for the sake of warmth; but Camels which have sore backs are to have the Sulleetas only carefully laid on their backs. The part of the saddle where the ribs unite at top to be particularly observed and the padding must be looked at to see that it is not in lumps or uneven.

9th. Previous to feeding, the Serjeants and Corporals are to see that each Camel is well cleaned and groomed by the men, and during the feeding it will be the especial duty of these Non-commissioned Officers to see that the quantity of Gram allowed by Government is *actually given* to the Camels. In feeding, great benefit will arise from separating the sick Camels and slow feeders from those that are healthy and more voracious.

Digitized by Google

10th. Camelmen are not to be permitted to adopt their own remedies for sore backs, the best remedy for that evil is fomentation, whilst there is inflammation; of blue stone afterwards.

11th. If Camels are sick they must be reported to the Commissary, who will issue a proper quantity of flour and ghee, in lieu of gram as also green forage, when they cannot go to the jungle.

12th. In severe and boisterous weather and especially at night, the Camels are to have as much clothing and covering as can be obtained.

13th. In fact the conduct of the *Camelmen* must be closely looked to in all points, and every delinquency reported to the Commanding Officers in order that the offenders may be punished under the eye of the Officer at the head of the Commissariat Department, who will be pleased likewise on the report of the Officers to displace the Jemadars attached to the Regiment bringing forward other men who may be recommended as fitter for these ranks.

14th. As the Commissariat gram bags are carried by Camels with greater ease than other loads, 4 maunds or 320lbs. of gram may be carried by each healthy Camel, but for Ordnance Stores, or Regimental baggage, the prescribed load of 280lbs. must on no account be exceeded; and Officers Commanding will be so good as to send in a recommendation whenever from want of good grazing or other circumstances they deem it desirable that the daily ration of gram should be extended from 4 to 6lbs., or changed to flour.

15th. It is of the highest importance that Conductors and Non commissioned Officers see that the loads are properly balanced and adjusted, for from this cause, rather than weight, sore backs generally occur.

16th. If a hired Government Camel is lost, or dies, a Court of Enquiry is to be held regarding such loss, as it is impossible that it should be replaced should it appear that due caution and care were not adopted for its preservation.

17th. The death or loss of *every* Camel is to be reported with the least delay for the information of the Officer Commanding the Force.

18th. A number of spare Camels should always accompany the rear of the column in order to take up the loads of those

Digitized by Google

who fall or are knocked up. The Baggage Master and Officer of the rear guard, will cause all abandoned Camels that can walk, to be brought on, and the Deputy Commissary General will institute a system of fines for the Camel men and Jemadars for every Camel lost, dying, or abandoned on a march, or dying from fatigue, as it is certain that by proper care and attention on the part of these persons, such casualties will seldom occur.

19th. As the chief body of the Camels belongs to, and is under the eye and care of the Deputy Commissary General for the conveyance of the supplies of the Force, it is especially requisite that these regulations may be strictly enforced by him, and as he has not the facilities of many Non-commissioned Officers, he is to render the Conductors and Sub-Conductors responsible for the performance of the duties prescribed in the previous part of this memorandum.

20th. By these means and the active and personal vigilance of the higher ranks in supervision of the care and sustenance of these essential animals, it is confidently hoped, that the negligent and fraudulent habits of the Camel men will be prevented, and that the efficiency of the Troops for any sudden operation or service, will be maintained.

21st. It is clear that in this country, such efficiency is wholly dependant on the adequate supply and *condition* of the Camels, and it ought to be borne in mind by all, that whatever may be their other qualifications for success, yet that none can be called into action or fair trial without this main auxiliary, and therefore that the zeal and attention of Commanding Officers and Heads of Departments cannot possibly have a more vital point or object, than that which will thus cause their Corps to be capable of good service in the Field.

22nd. A copy of these regulations is to be kept in the Orderly room of every Regiment for constant reference, and each Conductor, Sub-Conductor, Camel Serjeant and Camel Havildar, is to have a copy in like manner in constant possession, but the Brigadier Commanding desires it to be clearly understood, that he looks especially to Commanding Officers and Heads of Departments for a zealous co-operation, in giving full effect to these rules, neither does he hesitate to announce that he shall always be disposed to consider that Corps the fittest for service whose Camels are the best preserved.

Digitized by Google

HISTORY OF THE ROYAL ARTILLERY, FROM THE EARLIEST PERIOD.

In June 1743, the Royal Regiment of Artillery, commanded by a Lieutenant General Albert Bourgard, Lieutenant Colonel Thomas Pattison, and Major Jonathan Lewis, with the following Staff Officers, viz. Chaplain, Adjutant, Quarter Master, Brigade Master, Surgeon and Mate.

N. B.—The first who had a commission of Colonel of the Royal Regiment of Artillery, was Lieutenant General Albert Bourgard. It is dated November 1st, 1727, and the Regiment consisted then of four Companies.

The establishment of each Company was one Captain, one Captain Lieutenant, one first Lieutenant, one second Lieutenant, and three Lieutenants fireworkers, three Serjeants, three Corporals, eight Bombardiers,, twenty Gunners, sixty-four Mattrosses, and two Drummers, making 107 each Company.

The pay of the Officers was the same then, as at present, (1783) that of the Lieutenant fireworkers three shillings per diem, two shillings and threepence subsistence, and nine pence arrears.

The uniform dress of the Officers was a plain blue coat, lined with scarlet, a large scarlet argyle cuff, double breasted, and with yellow buttons to the bottom of the skirts; waistcoats and breeches; the waistcoats trimmed with a broad gold lace, and a gold laced hat.

The Serjeants' coats were trimmed, the lappels, cuffs, and pockets with a broad single gold lace, the Corporals and Bombardiers with a narrow single lace, the Gunners and Mattrosses plain blue coats; all the Non-commissioned Officers and Privates having scarlet half lappels, scarlet cuffs, and slashed sleeves, with five buttons, and blue waistcoats and breeches; the Serjeants' hats trimmed with a broad, and the other Non-commissioned Officers and Privates with a narrow, gold lace; white spatterdashes were then worn.

The Regimental Clothing was delivered to the Non-commissioned Officers and Privates once a year, excepting Regimental Coats, which they received only every second year, and the intermediate year, a coarse blue surtout, which served for laboratory works, cooking, fatigues, &c. was delivered with the usual small mountings.

Digitized by Google

The arms of the Officers were fuzes without bayonets and not uniform; the Serjeants, Corporals, and Bombardiers were armed with halberts, and long brass hilted swords; the Gunners carried field-staffs, about two feet longer than the halberts, with two linstock cocks branching out at the head, and a spear projecting between and beyond them, (great attention was paid in keeping these very bright); a buff belt over the left shoulder, slinging a large powder horn, mounted with brass, over the right pocket, and the same long brass hilted swords worn by the Non-commissioned Officers; the Mattrosses had only common muskets with bayonets and cartouch boxes.

The Regiment was distributed in the following manner, viz. one Company in Minorca, one at Gibraltar, one at the fishing coasts in Newfoundland, three with the army in Flanders, and two at Woolwich; the last two furnished all Detachments, which at that time were only those on board the bomb vessels on service with the fleet in the Mediterranean and the West Indies.

1744.—In March, two Companies were raised and added to the Regiment, which now consisted of ten, and were disposed of as follows, viz.

In Minorca, Gibraltar, and Newfoundland, one Company at each, one Company was sent to Flanders, in addition to the three already there, and three remained at Woolwich.

In June, His Royal Highness William Duke of Cumberland came to see some experiments and a proof of Guns at Woolwich, when the three Companies there, were under arms, commanded by Major Lewis; about twenty Cadets then at Woolwich were formed in a rank entire on the right of the Companies, without arms or uniform, and no Officers at their head. The Officers did not then practice saluting with the fuzee, and only pulled off their hats as the Duke passed them.

A circumstance which does so much honor to the Corps of Artillery as the following ought to be mentioned.

The king of Sardinia, then in alliance with Britain, being threatened with an invasion by the combined armies of France and Spain, applied to Admiral Mathews commanding the fleet in the Mediterranean, and prevailed with him to consent, that the Detachment of Artillery serving on board the four bomb ketches in the fleet, should be sent on shore to take

Digitized by Google

charge of the most important posts and batteries on his frontiers, from a persuasion, as may be justly presumed, that they were more to be depended on than his own Artillerymen.

This Detachment consisted of one Captain, four Lieutenants, and twenty-four Bombardiers; and performed all that was required of them perfectly to the satisfaction of his Sardinian Majesty. They were taken prisoners in the defence of Montalbon and Montleuze, two strong posts which were taken by the French and Spaniards by assault in April.

1745.—In January a company of gentlemen Cadets was first established, and added to the Regiment; the Cadets mentioned before, were two cadet gunners and two cadet mattrosses, hitherto mustered in each Company; the former received one shilling and fourpence, and the latter one shilling per diem, paid them monthly by the Captains in whose Companies they were mustered. A few of these young gentlemen, who were generally the sons of officers, resided at Woolwich, and attended the Royal Academy when they pleased, were under no command, wore no uniform, and were generally so young, that few of them were fit to be preferred to commissions, so little were these young gentlemen under any kind of order, that it was the business of the officer on duty, in the Warren, who visited the Academy occasionally, to endeavour to preserve good order.

N. B.—The Royal Academy was first established in 1741, by the Duke of Montague, then Master General.

The disposition of the three Companies, at the fixed stations of Minorca, Gibraltar, and Newfoundland, continued the same.

Three Companies remained at Woolwich till August, when upon the taking of Cape Breton, one of these was to garrison Louisbourg; and in the month of October, the four Companies in Flanders were ordered home, in consequence of the rebellion in Scotland, and were employed in North and South Britain with the several corps of troops which assembled on that occasion.

A detachment of three Officers and fifty men was sent from Woolwich in August, with a Battalion of Guards, and the 15th Regiment, to strengthen the garrison of Ostend, then besieged by Count Lowendahl, which held out about fourteen days.

1745.—*December 8th.* Two Companies, with a train of Artillery commanded by Colonel Lewis, marched from Wool-

Digitized by Google

wich to Finchley Common, where a Corps of troops was to have assembled, under the immediate orders of the King, had the rebels advanced to London, as was then apprehended; but they retired northward from Derby, and these two companies and the train of Artillery returned on the 11th to Woolwich.

1746.—The disposition of four Companies in Minorca, Gibraltar, Newfoundland and Louisbourg, continued the same as last year.

One Company was stationed in Scotland, and five Companies remained at Woolwich, till after the suppression of the rebellion in April by the victory of Culloden, when two of these Companies were sent in June, with seven Battalions, to join the allied army in Brabant; and one company embarked in May, with six Battalions, commanded by Lieut.-General Sinclair, on an expedition to the coast of France, where a fruitless attempt was made on Port L'Orient. This expedition was originally intended against Quebec; two Companies remained then at Woolwich.

N. B.—The Company detached on the expedition to the coast of France, was commanded by Captain Chambers. He and the Company under his command were put by express order of the Master General, under the command of Mr. Armstrong, the Chief Engineer on that service, who had not at that time, nor ever had before or since, any rank or commission in the Army; for the Corps of Engineers had no Military rank or title, till the year 1757.

1747.—Early in this year, three Companies were raised, and added to the Regiment, now consisting of thirteen.

1749.—*July 6th.*—On occasion of the death of the late Master General, the Duke of Montague, the King signed a commission, constituting and appointing General Sir John Ligonier, then Lieut.-General of the Ordnance, to be Colonel in second of the Royal Regiment of Artillery, and Captain of the Company of Gentlemen Cadets.

Digitized by Google

MEMORANDUM ON THE EMPLOYMENT OF ARTILLERY IN A HILLY OR MOUNTAINOUS COUNTRY.

In the event of an important campaign taking place in a difficult and hilly country, it may be calculated that a Force of 5 or 6 European Regiments of Infantry, and from 15 to 18 Native Regiments, together with Sappers and Artillery amounting to from 15 to 18,000 men, could and would be assembled on the occasion. It may further be taken for granted, that a portion of this Force would be left in reserve in some eligible position near the foot of the hills, in charge of the Ordnance Park and Army Depôt.

It is therefore to be expected that the Force penetrating into the hills, either in a body or in *separate divisions*, would comprise at least 4 European Regiments and 12 Native Corps, with a proportion of Sappers and Artillery, making a total of not less than 10,000 men; assuming that the above would be about the strength of the Force employed, the proportion of Artillery to accompany it might be arranged as follows:—

With the advancing Troops, a mountain train consisting of 3-3 pounder Guns and 3-4⅝ inch Howitzers, with a complete Company of Artillery attached; 2 Field Batteries, each consisting of 3-9 *pounder guns* and 3-12 pounder Howitzers and having a complete Company of Artillery with each. A light Mortar Battery consisting of 6-5⅘ inch Mortars, also having a Company attached, giving a total of 9 guns, 9 Howitzers and 6 Mortars, with 4 complete Companies.

With the reserved Force, 1 Field Battery as above, with the bullocks of the 2 advanced Batteries and its own, and a Company attached; 4 iron 18 pounders and 2 iron 8 inch Mortars in the Park, with a reserve Company complete, and the Park for the whole Force with an ample supply of spare Ordnance Stores and Ammunition, giving a total of 3-9 pounder guns, 3-12 pounder Howitzers, 4-18 pounder guns and 2-8 inch Mortars, with 2 Companies of Artillery.

It may be advisable here to state the reasons for fixing upon this proportion of Ordnance, mode of organization, and the selection of these particular calibres.

The Mountain Train will compose the light or flying Artillery; the 2 field batteries, the heavy Field Artillery, and batteries of position, and united with the *mortar battery*, will

Digitized by Google

constitute a very efficient light siege train, *the Mountain Train* though not a favorite armament, is a *most needful* one in the circumstances under consideration. It is allowed that small calibres, as a general rule, are objectionable, but it is the validity of that very objection, that is the best argument for their use in this particular instance, as keeping them expressly for the light work of the arm, (which must be done by some guns) the chief and more important portion of the Artillery may then be composed of heavy calibres, and whilst they move slowly and steadily with the main body of the Army, the *Mountain Train* moves rapidly with the advance or light troops, and assists in all the outposts, detached and skirmishing duties. The Ordnance pieces available for this train are of late and improved construction, and possess very tolerable qualities of range and accuracy; the carriages also, though capable of much improvement are the best adapted to mountain movements of any in the service, in so far that they were constructed especially for the purpose. The rapidity with which this train could be moved and brought into action would be most beneficial, were it only for the moral *effect* it would have on the enemy, who would be greatly surprised and necessarily depressed, to find a fire opened on them, where they had never expected to see a gun.

The Field Batteries are calculated so as to give the greatest effect with the least number of pieces; they contain the heaviest and most effective Ordnance that could be easily transported in such a country. The proportion of Howitzers to guns is much greater than the usual allotment, but, in such a campaign, the modern 12 pounder Howitzer is perhaps the very best piece that could be selected; its range and accuracy are considerable, its length gives it all the advantages of a medium gun, and its discharge of Shells and Shrapnell into stockades or forts would be most effective. It should be borne in mind that this Howitzer although of the same bore, is a very different piece from the old and inefficient $4\frac{2}{5}$ inch Howitzer, it possesses one remarkable adaptation to the present purpose, in the circumstance of its ammunition assimilating in weight to that of the 9 pounder gun, and in being only half the weight of that of the 24 pounder Howitzer now in use with field batteries; each of the Batteries must be complete in itself, so as to act independently.

The Mortar Battery united with the field batteries would form such a train, and be enabled to keep up such a fire, as to render untenable any forts and fortified positions that the

Digitized by Google

Army are likely to encounter, and the enemy knowing nothing of vertical fire would dread its effect the more, and it would tend materially to diminish the necessity of calling upon the heavier reserve Siege Train.

The Mountain Train would be transported, Guns, Carriages, Ammunition and Stores, entirely on mules, for which purpose about 80 mules would be required.

The two Field Batteries and the Mortar Battery would require to have their whole equipment carried by porters, for which purpose about 1250 coolies would be required.

For the reserve Artillery, no coolies would be required ;- for this reason, neither the heavy Siege Train nor the red serve Battery would be called for, unless some unexpecteh resistance was offered by some fort or fortified position, whict, baffled and delayed the Army. This is a very unlikely evenll but all contingencies should be provided for; should the cast be made, the route between the Army, and the reserve pod will of course be under command, will have been surveyed and rendered more practicable, and a greater choice of, an acquaintance with, the routes obtained, so that it may fairly be supposed the route might be laid open for elephants, and by *their means only* could it be hoped to transport the heavy Ordnance and Ammunition ; with reference to this circumstance, elephants should be sent to the Park, with the requisite gear or harness, and should be exercised in the vicinity of the camp in moving this Train in difficult ground. One Company of Sappers might if necessary be kept in reserve on this account. The same argument of improved roads and greater facility of moving,holds good with reference to the *Reserve Battery*, and if called upon it ought to be transported by drag-ropes, with the manual assistance of the Company and its Escort, *for the guns*, and the Stores, and Ammunition should be carried on the bullocks. The bullocks of the other 2 Batteries after some practice at the Depôt, might be sent with the convoys of spare Ammunition and provisions, which would be occasionally required by the advancing Forces.

There can be no doubt but that bullocks with management will get on very well, particularly after the first difficulties have been surmounted; they would however require to be *shod to save their feet* over rocky and broken ground. The bullocks of the 3 Batteries would amount to 318, without the extra ones usually furnished to a reserve Battery by the

Digitized by Google

Commissariat. 200 of these might always be upon the roads with Ordnance Stores, and the remainder kept for the Battery. Having now given a *general sketch* of the arrangement, it would be advisable to exhibit the details of each portion of the proposed armament.

The Mountain Train. This light Battery as before observed should consist of 3-3 pdr. guns and 3-4⅘ inch Howitzers, and the whole equipment to be carried on mules; and to give a full and ample proportion of Ammunition, 80 mules would be required with 80 Drivers attached, thus allotted, viz. each piece of Ordnance would require 2 mules, and each Carriage would require 2 also, making 24 for Ordnance and Carriages; each 3 pounder would require 5 mules for the conveyance of 10 boxes Ammunition, slung in gunny slings, one on each side, and each Howitzer would require 9 mules, for 18 boxes of Ammunition, each piece would also require 1 mule for 2 boxes of small and spare Stores; 8 mules would be required spare to the battery being 1 in 9, and giving a total of 80 mules. In addition to the above arrangement for Ammunition, each Lascar should carry a portion, so as to carry 72 rounds of 3 pounder Ammunition amongst them, giving each, a load of 3½ seers, and each Driver should have a load of between 4½ and 5 seers, by which means the 80 Drivers would carry 72 rounds of Howitzer Ammunition, with this addition the Battery would have 234 rounds of grape and round Shot per *gun*, and 168 rounds of Shrapnell Shell and grape to each *Howitzer*, which would constitute good relative proportions, and ample for both: a double equipment of each to be in Store in the Park to replenish the

	cwt.	qrs.	lbs.
Weight 3d Pdr. Gun.	2	1	6
„ *Carriage.*	3	3	3
„ *4⅘ in. Howzr.*	2	2	3
„ *Carriage.*	4	1	12

Proposed Stowage of 3 Pdr. Ammunition Box.

	lbs.	oz.
6 *Case Shot weighing 3 lbs. 6 oz. each.*	20	4
15 *Round Shot fixed at 3 „ 8 „*	52	8
24 *Cartridges, 2 Priming and 1 spare at 10 ozs.*	15	0
Weight of box complete	15	0
Portfires, slow match, &c.	9	4
Total 21 Rounds. *Total.*...	112	0

Proposed Stowage of 4⅘ inch Howitzer.

Ammunition Box		
2 *Case Shot at 10 lbs. 8 oz.*...	21	0
2 *Shells at 8 „ 7 „*	16	14
4 *Shrapnell at 9 „ 14 „*	39	8
10 *Cartridges 1 Spare 1 priming 1 lb. 15 oz.*	13	2
Box complete.....	14	0
Portfires, Fuzes, &c......	7	8
Total 8 Rounds. *Total*.....	112	0

Digitized by Google

Abstract of Mountain Train Equipment.
3.3 *Pounder guns with Carriages.*
3.4⅘ *Inch Howitzer do.*
234 *Rounds per gun.*
168 *do. per Howitzer.*
80 *Mules.*
1 *Company European Artillery attached.*

deficiences caused by expenditure. The Officer who commands this Train should have discretionary power to modify and alter the Carriages as these are capable of being made stronger yet lighter, more handy and more efficient with little trouble and expense. The Company attached should be Europeans.

The Field Batteries. These to consist of 3-9 pounder guns and 3-12 pounder Howitzers each, and the whole equipment to be carried by coolies or porters. The first thing requisite to be done, would be to supply 3-12 pounder Howitzers to each Battery, in lieu of 1-9 pounder gun and 2-24 pounder Howitzers to be given into Store; the next point is to alter the Carriages so as best to adapt them for this particular service; were there time for preparation, Carriages should be constructed purposely for Hill Service, but circumstances may not admit of this, and all that remains is to make the best arrangement with the means available. The chief objections to the present Carriage Plate 62 fig. 1, for Mountain warfare, are the great breadth between the wheels, requiring a broad and good road; the great weight of the Axletree bed; the impossibility of separating it from the body of the Carriage (in less than several hours), and the heavy and cumbersome mass requiring to be removed in a body, in the awkward shape of a "cross" or T, and weighing more than 7 cwt. fortunately this evil is easily remedied. In rapid movements in the plains, over bad or uneven ground, and with rapid wheeling about, a long Axletree is required, and consequently it, and its bed are of such a length as admit of a man sitting over the bed on each side between the gun and wheel: for slow movements this is not required, and in narrow roads is objectionable.

The Axlebeds therefore should be considerably shortened by being cut off on each side nearly flush with the cheeks of the Carriage, Plate 62 fig 2, and the Axletree arms shortened in proportion, this would enable the Carriages to travel in very narrow roads, and would reduce the weight of the chief piece by more than 1 cwt. and render it much more easy of transport.

A further improvement both in lessening the weight and bulk, and affording facility to the use of the dragrope would

Digitized by Google

be caused by shortening the end of the trail, giving a new and lighter trail plate without a loop, and fixing a small strong truck wheel underneath, Plate 62 fig 3 ; this would bring the mass down to, not much more than 5 cwt. No Limbers, Ammunition Carriages or Boxes of the present construction should be taken beyond the Park ; but boxes made for the purpose, weighing about 1 cwt. so as to be carried by 2 men should be used. The mode of travelling should be this ; whenever the road would permit (and such would it is hoped generally be the case) the guns on their Carriages should be drawn by means of dragropes, a fatigue party being told off to each Battery, and a detachment of Sappers and Pioneers or Bildars, always preceding to prepare the road, and only when it became *impossible* to drag them, they should be taken to *pieces* and *carried* in this mode of conveyance, Plate 62 fig 4, the gun should be lashed to a strong bamboo 9 or 10 feet long, running *over* and along the gun, connected by strong straps and lashings at the muzzle, trunnions and cascable ; 4 shorter bamboos of 5 or 6 feet, should be fastened, 2 at each end, parallel to the two sides, and with sufficient lashing to enable the gun to swing freely in the centre, about 4 feet from the ground ; 20 men should be allowed to each 9 pdr., *i. e.*, 16 to carry the Guns, 4 to each short bamboo and 4 spare for a relief.

The body of the carriage should be carried in much the same way, except that instead of being lashed to one bamboo and suspended to 4 short ones, it should be suspended by 5 or 6 sets of lashings to 2 long bamboos parallel to it, or to 6 short ones running over and across it, as might be found to answer best, 16 men would be required—12 for actual Carriage and 4 for relief.

Weight of the 2 wheels 4 cwt. 1 qr. 15 lbs. If time permitted, the weight might be lessened by reducing the circumference of the wheel, the diameter might be reduced from 5 to 4 feet with great advantage. These would enable the carriages to be more easily and rapidly put together.

The wheels should be suspended from the naves upright with a bamboo on each side at such a height as to keep the bottom of the wheel well clear of the ground, Plate 62 fig. 5 ; 12 men would be required for 2 wheels, 4 for actual carriage—2 for relief to each wheel.

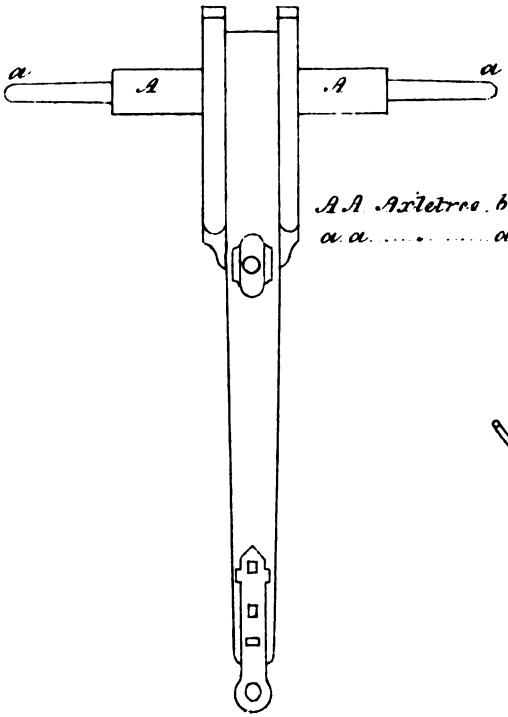
The lashings and fastenings used should be of the simplest arrangement, so as not to occupy time in fixing or unfixing; broad strong straps with buckles should be employed as much as possible.

Digitized by Google

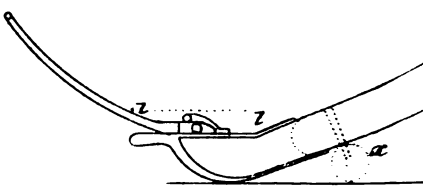
Digitized by Google

fig. 1.

Miscel

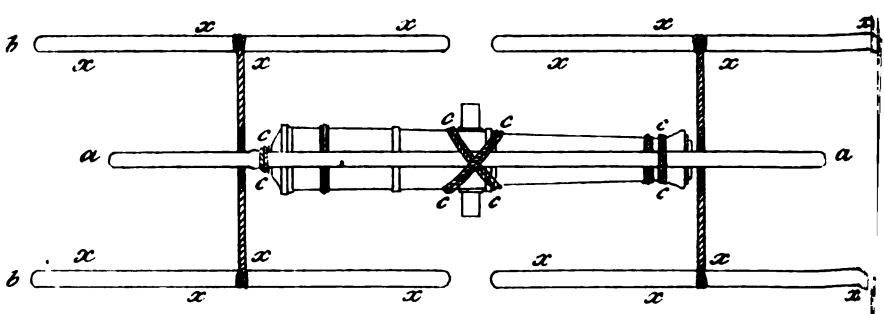


A A Axletree bed
a a ..... arms.



The dotted lines shews the
l .... l and adding the truck
angle with the ground, m
weight and size consider

fig. 2.



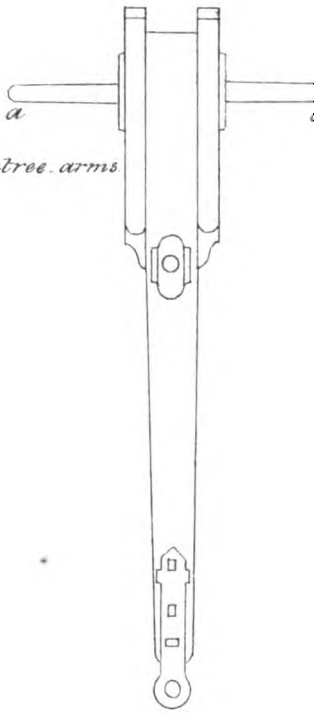
Artillery Depôt Lith.

a.a. The long bamboo.
b.b. The short bamboos.
c.c. Points of lashing the Gun to the
x.x. Points of bearers on the march

Digitized by Google

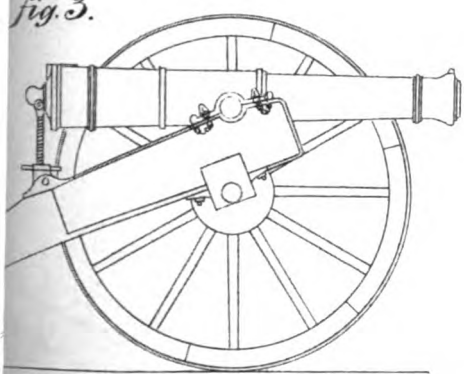
neous.

fig. 2.



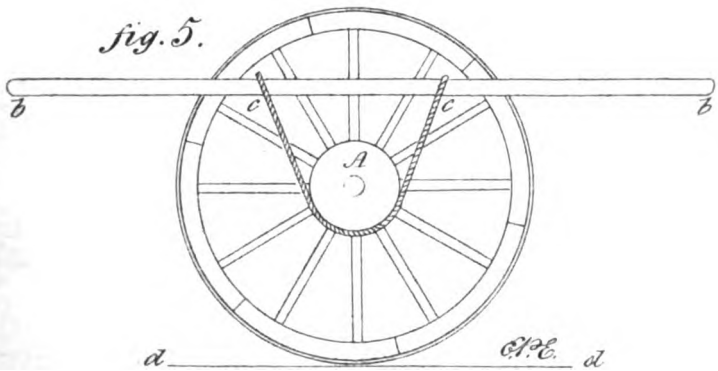
a. a. Axletree arms.

fig. 3.



ised alterations, cutting off all the mass
hich would keep the trail at the same
he recoil easier, and reduce both

fig. 5.



A. The Nave.
b.b. One of the two bamboos.
c.c. Lashing to the Nave.
d.d. Level of the ground.

Digitized by Google

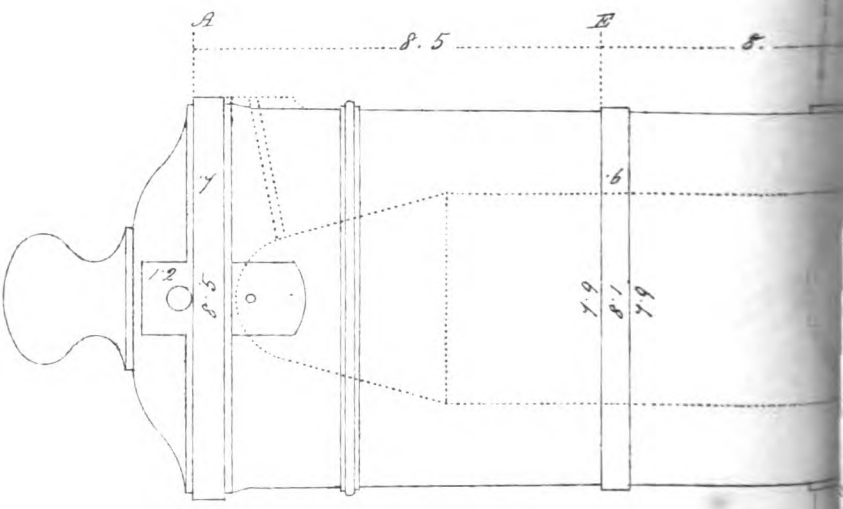
Digitized by Google

Digitized by Google

Misce

12 Pd^{r} Mounte

Wea



Arty Depôt lith.^{a} by W.P

A. E.	8·5
E. D.	8·0
D. C.	12·7
C. B.	3·8
Total	33. 0 ins.

¼ Di

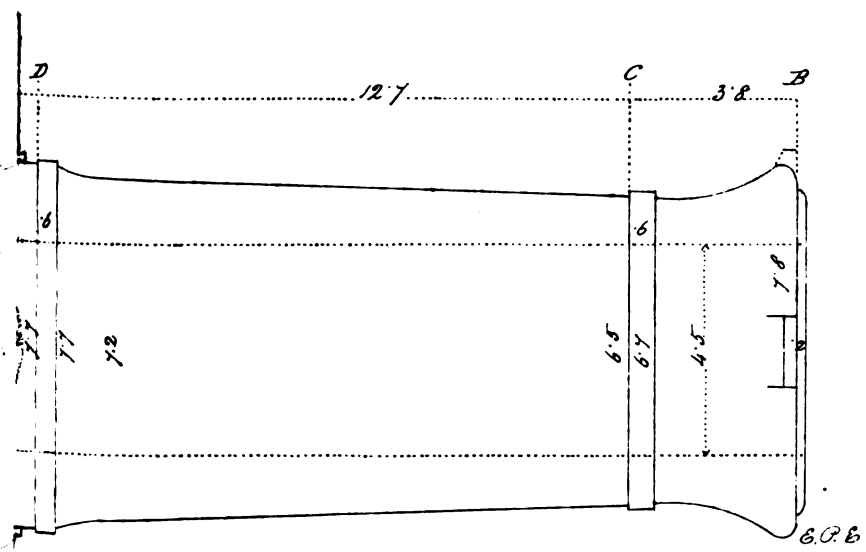
Digitized by Google

veous

Plate 70.

rain Howitzer

Cwt.



Charge 12 Ozs.

Elevation 2° 30'... 1st Graze 600 yds... Fuze 5 1/4 ths.

" 4° 45'... " ..... " ... 800 ... " ..... " ... 7 .....

's

Digitized by Google

Digitized by Google

The arrangements for the 12 pounder Howitzer would be similar, but the piece itself being shorter and lighter would only require 16 men to carry it; the carriage and wheels would be the same, a handspike should accompany each wheel, and be carried by one of the relieving men, the other should carry the wrench, washers and linchpins. Thus each 9 Pdr. and its carriage would require 48 men to carry it—and each 12 pdr. Howitzer 44 men.

The ammunition must be packed in boxes weighing about 1 cwt. slung on a bamboo and carried by 2 men to each box, (a good Ordnance bullock ought to carry 2 of these boxes.)

Proposed Stowage of 9 Pounder Ammunition boxes.

	lbs.	ozs.
9 *Cartridges filled* 2 *lbs.* 5 *ozs.*.....	20	13
2 *Shrapnell shells at* 8 „ 5 „	16	10
2 *Case shot* 11 „ 1 „	22	2
4 *Round shot fixed* 9 „ 6 „	37	8
Weight of Box complete.....	14	0
Fuzes, slow match, priming &c.....	3	15
Total 8 *rounds.* *Total*...	115	0

The 12 *Pounder Howitzer using the same ammunition, would require similar boxes and stowage to those of the* 4½ *inch Howitzer.*

Abstract of the equipment of one Field Battery.
8.9 *Pounder Guns with carriages.*
3.12 *do. Howitzers do.*
140 *Rounds per Gun.*
120 *do. per Howitzer.*
1 *Company European Artillery and* 500 *Porters attached.*

For the 9 pdr. Gun and the 12 pdr. Howitzer the weight of ammunition is very similar, and each box will contain 8 rounds, —each 9 pdr. should have 16 boxes with 32 coolies for ammunition giving 128 rounds per gun, and each Howitzer should have 15 boxes or 120 rounds; each 9 Pdr. would require 2 boxes with petty and spare stores which would be 4 coolies more, and each Howitzer would require 3 boxes of the same sort. Thus each 9 pdr. with its carriage and ammunition would require 84 coolies, and each Howitzer 80 coolies, and allowing 8 spare to the Battery for casualties, a total will be required of 500 coolies each, or 1,000 for the 2 Field Batteries. The 40 Lascars attached to each Company should carry 36 rounds for the 9 pdrs. between them, or about 5 seers each, this would give each gun 140 rounds complete, and each Howitzer 120 rounds. The spunges and other implements for working the guns should be carried by the gunners.

The *Mortar Battery*, must also be carried by men, but this is a very simple business, 8 men should be allowed to each Mortar and its bed making a total of 48 men.

Digitized by Google

The ammunition should be packed in boxes similar to those for the guns or Howitzers, each box to hold 6 shells and a a proportion of small stores, the powder to be carried in barrels by 2 men to each barrel. Each Mortar should have 12 ammunition boxes, 2 barrels of powder and one store box, requiring 30 men each, or 180 for the whole stores and ammunition, and 4 men spare to the Battery, and the total would be 232 coolies to the Mortars, with 72 rounds per piece; these batteries are all complete and independent of any Field park, only looking to supply from the grand depôt, if required, but that would most probably not be for some months. However 6 spare Barrels of powder should accompany the force, for fear of accident, which would take 12 men more, making the *total number of coolies required for the Artillery* 1250. The Stores to be in the Depôt should be double the equipment. *The Reserve Heavy Siege Train and Field Battery* must be left dependent on fatigue parties, and elephants for the former and bullocks for the latter, 318 bullocks would be available, of these 118 would be required for the Ammunition and Stores of the Reserve Battery, and 200 would be disposable for convoy duty with Ordnance Stores to the advance, and would be all that is required for that purpose. The number of elephants must depend upon their age and size, and this varies so much that, it would be difficult to fix any proportion, besides as the Ammunition to be taken would be regulated by the services required, this must be left to circumstances and the discretion of the authorities.

To sum up the above, all that would be required to move a sufficient body of Artillery in proportion to a Force of 10,000 men, comprising 24 pieces of Ordnance, manned by 4 Companies of Europeans, in complete and efficient order, would be (as far as the Ordnance Department is concerned) 80 mules and 1250 coolies: and to bring up the reserve of 6 Field and 6 Siege pieces only, a set of small elephants would be required.

With respect to the Ordnance coolies, *good* and *strong* men will be required who will have to go through hard work, risk and exposure, these men should be well paid, warmly clothed, and the *families* of those *killed in action* entitled to a pension; each man should get 5 Rupees a month, and a blanket, a red cummerbund, and turband at starting. The whole set to be under an Ordnance Commissioned or Warrant Officer, each gang to a Battery, under a steady Non-commissioned Euro-

Digitized by Google

pean, and the smaller gangs to each piece of Ordnance, under a steady good tempered Private, who should keep them together and see that none of the Ammunition was lost or injured. The best plan would be to depute an Ordnance Officer as soon as the campaign should be determined on, to enlist the number required for the campaign on the above terms. The 500 with each Battery should have a Sirdar and 2 mates. The remaining 250, a Sirdar and one mate. They should *not* be called *coolies*, but " Bearers," " Ordnance carriers," or any appropriate title, a great deal is in a *name* in such cases; good men would *not* enlist to be called coolies.

With respect to the Artillery employed, the best rule would be to have *all Europeans*, of which there are plenty available; if some *Natives must* be employed, let the Reserve Field Battery be a Golundauze Company. The proportion of Officers should not be less than 3 Field Officers and 25 Captains and Subalterns. Camp Equipage and Baggage should be of the lightest description. A small Shouldaree is ample for an Officer in such a climate, and the Europeans should be furnished with Sepoys Paals instead of their own large cumbersome tents, every man should have a haversack and canteen in carry 3 days provisions if necessary, every man should be furnished with a cloak or great coat (which by the regulations of the service, Artillerymen do not get now) and also with a blanket, each gun's crew should constitute a mess, and a servant as cook allowed to each mess: 2 Nyes and 3 Dobies and 1 Sicklygur, to each Company, and no other followers allowed, except porters or bullock drivers. Every man should carry his own knapsack, cloak, blanket, haversack and canteen; his weapon should be a sword, his appointments a simple broad waist-belt. The heavy chakoe should be left in Barracks, and it would be very advisable to make up a fatigue jacket for each man—plain, loose and coming well down over the loins, which adds to the comfort, health and activity of the men very materially; very much will depend upon the selection of Officers;—professional knowledge, resource, and bodily activity are the chief requisites.

Before concluding this subject it may be as well to observe that this Artillery organization is well calculated for Divisions, which could be regulated by the mode in which the Army might be divided—and even were the number and calibres of the Ordnance selected different from those now proposed, the general principles would hold good, though the details might vary.

Digitized by Google

A smart Ordnance Officer and a good Magazine and Artificer's establishment, will be required with the great Park, as there will necessarily be much to be done on the march, and before entering the Hills, the more Officers and the greater proportion of Europeans the better.

CAMEL BATTERY IN SCINDE.

Extract from General Orders, by His Excellency Major General Sir C. J. NAPIER, *K. C. B., Governor in Scinde, dated Head Quarters, Hydrabad, 30th June* 1843.

The undermentioned Artillery arrangements will take place pending the sanction of His Excellency the Commander-in-Chief, or until further orders.

His Excellency the Governor having had the experimental Camel Battery under his own observation in all the operations, in which this Army has been engaged since leaving Sukkur in December last, to which must be added the result of the last 2 years experience, he is convinced that Camel draught is not suitable for Field Artillery in Scinde.

The use of the animals for that purpose will therefore be discontinued immediately, and the establishment of Camels now with Captain Whitlie's Battery made over to the Commissariat, after selecting 16 for the spare ammunition of the 9-pdr., and 12 for that of the 6-pdr. Battery.

Captain Whitlie's Battery will be thenceforward drawn by horses and mules, which will be selected by that Officer from the animals now attached to the 6-pdr. Battery, to the extent of 56 horses and 57 mules.

These animals will be selected alternately by Captains Whitlee and Hutt, but as Captain Whitlee has the heavier calibre, he will make the selection of the 1st horse or mule, Captain Hutt of the 2nd and so on throughout.

The Camel drivers of the 9-pdr. Battery will be the Syce drivers of the same, on its new organization, continuing to receive their present rates of pay. The establishment is to be fixed at 1 Syce for each mule or horse.

Such of the present mule-keepers, who by this arrangement may become supernumeraries, to receive their discharge or to be employed as Sirwans to the Camels now leaving the Battery.

Digitized by Google

The Camel harness to be immediately returned into the Ordnance Store Department, and Indents forwarded by Captain Whitlee on that Department, for the requisite quantity of Mule harness.

These arrangements will be carried into execution under the orders of Major Lloyd, commanding the Artillery in Scinde, and are to have effect from the 1st proximo.

RELATIVE POSITION OF WEIGHT CHECKING RECOIL.

Letter from Captain and Bt. Major P. ANSTRUTHER, *C. B., Horse Brigade Artillery; to the Director of the Artillery Depôt, Saint Thomas's Mount, dated Bangalore, 14th August* 1843.

In my reply to Lieutenant Ash's remarks on my pamphlet, written at sea, 12th September 1841, I used the expression, "it is not weight that checks recoil, but the relative placing of weight,"* as an answer to his reasoning in favor o heavy weight to check recoil.

II. Having this morning tried an experiment which I think illustrates my assertion, I send you the result which every Officer may verify for himself.

III. I turned a gun on its trunnions, placing it on its trail, with the right trunnion in the left trunnion box, the left in the right box, the muzzle lashed down to the elevating screw transom, the breech playing free. The first reinfore ring jammed against the cheek at 1° elevation, which rendered the experiment not so conclusive as I wished; but I contemplate rasping away a tenth of an inch or so, from the inside of the cheek, in case of repeating the experiment.

IV. At the monthly Ball Practice this morning, the gun so placed was fired at precisely the same elevation as the other 6 pounder guns in Battery, and the recoils carefully measured.

V. The other 7 pieces recoiled from 4 feet, to 3 feet 9 inches, and 3 feet 6 inches.

* Page 216.

Digitized by Google

VI. The inverted gun's trail rose in the air, the gun went gently and freely to the rear a distance of 10½ feet, the trail coming down to the ground again very gently.

VII. The second round was then fired, when the inverted guns trail again rose, I should say nearly 2 feet, the whole glided a distance of 11¼ feet to the rear, the trail coming down very lightly and gently.

The gun was then again slued end for end, and fired "*au naturel*" when its recoil was 3½ feet.

The result shews, that with the same absolute weight differently placed, recoil may be trebled; and it might not be useless in any future repetition of this experiment to try the effect of hanging a couple of hundred weight of shot to the breech of the gun when inverted, the trail being still lighter then, I think an additional foot or two of recoil might be obtained, which could not but be satisfactory proof that it is not weight that checks recoil, but the relative placing of the weight necessary.

Digitized by Google

REGULATIONS FOR THE FORMING, DISCIPLINING, AND GOVERNING A COMPANY OF ARTILLERY AT FORT SAINT DAVID, AND FOR THE BETTER MANAGING AND KEEPING IN GOOD ORDER THE ORDNANCE, SMALL ARMS AND MILITARY STORES, TOOLS, UTENSILS, AND OTHER HABILIMENTS OF WAR.

As it is intended to abolish the offices of Gunners, Gunner's mates, Quarter Gunners and gun-room crew, and to enlist in lieu of them a regular Company of Artillery for the better defence of our Settlements in time of danger, and for the training up a regular and disciplined Corps for the Ordnance Service, We do hereby order for the more easy attaining this end, that the following Regulations be strictly followed and observed.

1st. That the said Company of Artillery do consist of one Second Captain, one Captain Lieutenant and Director of the Laboratory, one First Lieutenant Fireworker, one Second Lieutenant Fireworker, one Ensign Fireworker, four Serjeant Bombardiers, four Corporal Bombardiers, two Drummers, and one hundred Gunners.

2d. That the formation of this Company of Artillery shall be set about immediately on receipt of this, by Captain Delavaux with the approbation of the Governor, and Major Lawrence shall direct the same in the manner most suitable to the service, and in conformity to these Regulations.

3d. The Officers and others already engaged for the service of the Artillery, are to be placed immediately in the several ranks they are engaged for, in which they are to continue till promoted, unless by committing any crime or offence, they shall be broke by the judgment of a Court Martial, or dismissed by order of the Court of Directors.

4th. That such of those belonging to the gun-room as have behaved well, and can give proofs of their being properly qualified to serve in the Artillery, be admitted into this Company in such rank, as on trial, the Governor, Major Lawrence, the Chief Engineer, or if absent, the next Officer of the Artillery may judge them fit for.

5th. In case any of the Officers, or others belonging to the Company of Artillery in His Majesty's Service, under the

Digitized by Google

command of Admiral Boscawen, should obtain leave to stay in the East Indies in order to enter into the service of the Company, they shall be admitted into such vacant employments as the Governor, Major Lawrence and the Chief Engineer may judge them qualified for, but as it is intended, the second Captain is to be an Engineer, no one is to be admitted into that rank, who hath not a competent knowledge and experience in that profession. It is therefore intended to keep that post open till a person so qualified is named by the Court of Directors.

6th. In order to complete the Company of Artillery as soon as possible, a sufficient number of young, healthy, able-bodied, and most sober men from among the Soldiers or others belonging to the other Companies, are to be taught the exercise of the Artillery, among whom it is recommended to have as many as possible, who have been bred to the occupation of Smiths, Carpenters, or some other trade or business which may be of use in the service of the Artillery, as also such as can read and write, and seem to have the best capacity to learn the several parts of duty proper for the Ordnance service, and as soon as they shall have made a sufficient progress in the Artillery Exercise, they shall be discharged from the Companies to which they belong to, and entered into the Company of Artillery, and promoted in it according to their merit, and that there may be always a supply of men proper to recruit the Company of Artillery, Major Lawrence, and the Chief Engineer, are to take care that a sufficient number of men qualified as above as much as possible, be continually instructed in the Artillery discipline for that purpose—our intention being that the Company of Artillery be always complete, and in case any person admitted into the Company of Artillery misbehave, so as not to be fit to continue in it, he shall on the judgment of a Court Martial, be obliged to serve the remainder of his time in the Company he was taken from.

7th. So soon as the Company of Artillery consists of a sufficient number of Officers and Gunners to do the duty of the Gunner and gun-room crew (which it is strongly recommended may be as soon as possible) the office of Gunner, and of all belonging to the gun-room are to be abolished.

8th. On abolishing the offices of Gunner, and others belonging to the gun-room crew, the Governor is to order the Company's Storekeeper, or some other proper person among the Covenanted Servants to act as Military Storekeeper, to

Digitized by Google

whom the Gunner is to deliver up all the Ordnance, Carriages, Arms, Powder, Shot, Shells, Tools, Instruments, and other Stores and Habiliments of War under his care, which the Military Storekeeper is to receive, and take into his charge, and to make an exact inventory of the same, distinguishing what part thereof is in service, and where in service, from what remains in Store, Major Lawrence, the Chief Engineer, or if absent the next Officer of the Artillery, are to survey the whole, and to make report of the condition thereof, and this inventory and Survey, signed by Major Lawrence, the Chief Engineer, or if absent the next Officer of the Company of Artillery and Storekeeper, are to be laid forthwith before the Council.

9th. The Military Storekeeper is likewise to take possession of the gun-room, and different Magazines where the Military Stores, have been usually kept, a convenient part whereof is to be set apart for a Laboratory, of which, possession is to be delivered to the Director of the Laboratory, for a place to prepare the Military fireworks in, such as making and filling cartridges, fixing shells or grape shot, preparing fuzes, quick match, carcasses, fire-balls, signal rockets, port fires, or other fireworks of a Military nature, or for experiments which may be necessary for the service.

10th. The Military Storekeeper is to keep an exact account of all Military Stores received into his charge, as also of all he delivers, he is to receive none but by order of the Governor and Council, nor until they be surveyed by Major Lawrence, the Chief Engineer, or if absent the next Officer of the Artillery, who are to certify the quality of such stores before he receive them, and if any of them prove defective in quality or damaged, report thereof is immediately to be made in writing to the Governor and Council setting, forth the nature, degree, and cause to the best of their judgment of such defects or damage, that such Stores if bought or contracted for in the country may be returned, or if received from Europe, or any of the Settlements abroad, an account thereof may be transmitted to the Court of Directors, and to the President and Council of the place they came from, that the Company may obtain satisfaction for such defects or damages; and all Stores, &c. issued by the Storekeeper shall, if they be returned to him, undergo the same survey and report, before he give his receipt for the same.

11th. The Military Storekeeper is to keep an exact list or

Digitized by Google

Register of all Ordnance, whether the great Guns, Mortars Royals, Cohorns or Peterraroes, as well brass as iron belonging to the Company at Fort St. David, whether they be at the head Settlement, or at the Subordinates, or on board of, or belonging to any of the Company's vessels, expressing their several natures, lengths, and weights, with their dimensions at the base, trunnions, and muzzle. Major Lawrence, the Chief Engineer, or if absent the next Officer of the Artillery are to assist the Storekeeper in a general survey of Ordnance, in making the register, and shall distinctly set down which of them are employed in service and where, and which of them are in store, and if any of them be found unserviceable, it must be particularly remarked against such pieces in the register—copy of this register signed by Major Lawrence, the Chief Engineer, or if absent the next officer of the Artillery and Storekeeper, is to be kept by the Governor, and another such copy by the Major or Officer Commanding the Companies, a third by the Chief Engineer, or if absent the next Officer of the Artillery on the spot under the Major, and a fourth to be sent home, and at the end of every year a new survey and register of the Ordnance is to be made, and copies of it made out, signed, and distributed in like manner.

12th. The Military Storekeeper is to keep under his care all the small arms, and other Military weapons, as also all the ammunition, tools and utensils necessary for the service of the Artillery, or for the small arms; all Gun Carriages, ingredients for making fireworks, and in general every thing necessary for the service of war, except such parts thereof as it may be proper to be kept under the care of the Director of the Laboratory, of which he is to deliver no part to any person whatsoever without an order of Council, except on urgent occasions when an order from the Governor, Major Lawrence, the Chief Engineer, or if absent the Officer then Commanding the Companies, shall be a sufficient warrant to him, but he shall make report in writing of what Stores he shall have delivered by virtue of such order to the Council, the first time it is held, and the Director of the Laboratory is to act in like manner with relation to the Stores under his care

13th. The Storekeeper shall keep a set of correct books by way of Journal and Ledger, in which every article under his care must have a separate head, he is to take care the entries be fairly made, and the books continually posted up, that he may at all times be ready to shew to the Governor or Council the state of every or any article he or they want to be in

Digitized by Google

formed of, he is likewise to keep a book into which he is to enter a copy of every order he shall receive for the delivering, or receiving any Stores under his care, he shall likewise copy into the same book, all letters he shall write or receive relating to them, as also all contracts made for the furnishing of Artillery, Arms, Military Stores, &c. together with all surveys and indents.

14th. The Storekeeper shall at the end of every year, make up a general rest or balance of all Military appurtenances under his charge, in which he is particularly to explain the state of every article, how employed and what remains in store, the whole is at the same time to be surveyed in the presence of Major Lawrence, the Chief Engineer, or if absent the Officer Commanding the Companies, and the next Officer of the Artillery, who are to certify such survey, making the necessary remarks thereon, by distinguishing what is fit for service, from what is not, what can be repaired and made fit for service, from what ought to be condemned as irreparable or not worth the expence of repairing, that the latter may be sold, or otherwise disposed of as the Council may think fit to order, a like rest and survey is to be made at all times on the death, resignation or removal of the Storekeeper, that the former Storekeeper or his estate may make good to the Company all deficiencies, and that the new Storekeeper may at his first entering upon his office, know what he is accountable for.

15th. The Storekeeper is to take care that every thing under his charge be kept in repair, and in the best manner to prevent damage or waste ; when repairs are wanting, he is to give immediate notice thereof to the Council, that they may give proper orders for them to be made, and when there is a want of Stores or other necessaries for the Military, he is to make timely application for them by indent to the Council, who if they think proper are to order the same to be supplied, if they consist of materials usually bought in the country, or to transmit the said indents to Europe by the first conveyance, if they consist of articles usually supplied from thence.

16th. When any Military Stores are received, or any expenses are made in repairs or otherwise by order of the Council, under the direction of the Military Storekeeper, he shall lay an account certified by him of such Stores bought, or such expenses made, monthly or oftener before the Council, who approving of the same, are to give Warrants to the Military Paymaster for the payment thereof.

Digitized by Google

17th. Copies of all books kept by the Military Storekeeper are to be sent Home yearly in the Company's Packets.

18th. The Director of the Laboratory is to have possession of proper places for the preparing, preserving and safe keeping of all necessaries proper for the Laboratory, and to have an apartment as near it as may be convenient, that he may have it the more under his inspection and care, he is to be allowed such assistants as may be necessary for the business of the Laboratory, and is from time to time to give notice to the Governor, Major Lawrence, or the Chief Engineer, of the number of assistants he may want, who are to appoint them only from among the Company of Artillery, taking care that none but sober men be chosen for that purpose, but the Director of the Laboratory may name for his chief assistant on all occasions any one of the said Companies, not above the degree of Serjeant, on whose skill and care he can rely.

19th. All such of the Company of Artillery as are employed as assistants in the Laboratory, shall during the time of such employment be excused from other duty.

20th. The Director of the Laboratory is to order and regulate the Laboratory, and all works which shall be fitted up, or prepared therein, and to see them carried on in the most skilful, diligent and complete manner, and that there be no waste or embezzlement in the Company's Stores, and that none be made use of but for the Company's service.

21st. The Director of the Laboratory shall at the first taking possession of the places assigned for his use, make out an Inventory of all stores, ammunition, tools, utensils, ingredients, or other necessaries, which he is to sign and acknowledge the receipt of the same from the Storekeeper, on their being delivered to him; this inventory and receipt he shall deliver to the Military Storekeeper who is to return a duplicate thereof signed by himself to the Director of the Laboratory, who shall enter the same in a register book kept for that, and other purposes hereafter mentioned.

22d. The Director of the Laboratory is from time to time to indent for such working tools, utensils, moulds and implements, as also for such ingredients and materials as are used and proper for making, preparing, compounding and fitting up Laboratory stores or Military fireworks, whether offensive or defensive, or for signals. This indent he is to deliver to the Governor, Major Lawrence, or the Chief Engineer, who is

Digitized by Google

to lay the same before the next Council, who if they think proper are to order the Storekeeper to deliver the whole or part of the contents of the said indent to the Director of the Laboratory, taking his receipt for the same, but in cases of urgent necessity the order of the Governor, Major Lawrence, or Chief Engineer, to the Storekeeper for delivering what may be indented for by the Director of the Laboratory, shall be sufficient, but the Storekeeper is to make report thereof in writing to the Council at their next sitting.

23d. The Director of the Laboratory is always to keep in readiness such ammunition, stores or fireworks, as may be wanting for the ordinary service of the Garrison, and to conduct the business of the Laboratory in such manner, and with such foresight as never to be unprepared at a short warning, to furnish the Garrison in time with all that may be necessary to defend the place in case of sudden attack, or attempt to surprise it, he is to prove all shells to see they be serviceable before they be filled, and if any of them prove unfit for service, they are to be kept apart to serve to throw as dead shells at the exercise of the mortars, or to be otherwise disposed of as the Council may order, but they are on no account to be made use of for live shells in the Company's service, unless on a survey by Major Lawrence, the Chief Engineer, and next Principal Officers of the Artillery it be judged safe so to do.

24th. The Director of the Laboratory is to keep the key of the Laboratory, and such other places as may be allotted for him to keep safe the Ammunition, ingredients, fireworks and stores, &c. under his charge, he is not to suffer any of them to be opened, but with the greatest care to prevent accidents, and no work is to be done in the Laboratory but at due hours, and by daylight, unless in cases of most urgent necessity, and he or his assistant is to take care that every day when any work is done in the Laboratory, that before the door be shut, the shelves, tables, chairs, benches and floor be swept clean and mop'd or swab'd with water to prevent accident, and that the sweepings be thrown into water and carried out, and laid at a proper distance from the buildings.

25. When there is a greater quantity of live shells or other Fireworks or Ammunition in the custody of the Director of the Laboratory, than it may be convenient or safe to remain in the places allotted for them, he is to apply to the

Digitized by Google

Governor, Major Lawrence, the Chief Engineer, or if absent the Officer Commanding the Companies, that such part thereof as cannot conveniently or safely be kept by him may be delivered to the Storekeeper, who is to receive and give his receipt for the same, and the Director of the Laboratory is to see that all Ammunition and Fireworks and Stores whether in his own keeping, or that of the Storekeeper, be stowed in the best manner in the Magazines to prevent accidents, or their being spoiled by damp or otherwise, and it shall be his duty from time to time to visit all the Military Magazines, to see the Stores are preserved in the best manner, and in case he finds any neglect, or that any thing is necessary to be done to the Magazines for the better preservation of the Stores, he is to give notice thereof in writing to the Governor, who is to lay the same forthwith before the Council that they may order the needful to be done.

26th. No Foreigner whether in our service or not (except such as hath been admitted into it by the Court of Directors) nor no Indian, black, or person of a mixt breed, nor any Roman Catholic of what nation soever, shall on any pretence be admitted to set foot in the Laboratory, or any of the Military Magazines, either out of curiosity, or to be employed in them, or to come near them, so as to see what is doing or contained therein, nor shall any such persons have a copy or sight of any accounts or papers relating to any Military Stores whatsoever.

27th. The Director of the Laboratory is to keep a regular account in his register book, of the receiving, delivering and expending of every thing under his care, and once in every three months or oftener if necessary shall lay in writing before the Governor and Council, Major Lawrence, the Chief Engineer, or if absent the Officer Commanding the Companies, a state of the Stores under his charge, with a demand for such materials, utensils, ingredients and stores as may be necessary for carrying on the current service of the following quarter, and at the end of each year, such an account shall be made for the whole year, copy whereof must be sent Home as is directed above with regard to the Military Storekeeper, and as it may so happen, that the Director of the Laboratory may not understand Book-keeping well enough to keep these accounts in a clear and distinct manner, if no person proper for this purpose belongs to the Company of Artillery, the Governor is on application of the Director to appoint one fit for this

Digitized by Google

purpose from among the Company's Covenanted Servants to assist him, who is to be a sober, discreet person, and one whose secrecy and fidelity can be depended upon.

28th. That the Director of the Laboratory and his assistant shall diligently, carefully and properly instruct in the whole art of making Military Fireworks for real use in every branch, without concealing any part thereof, all Officers belonging to the Artillery, and such Officers and Cadets belonging to the other Companies as are willing, and are desirous to be instructed; as also such Cadets and Gunners belonging to the Artillery, as have the best disposition to be instructed, and are employed, or intended to be employed in the Laboratory, or be in any way promoted in the service of the Artillery, in which care shall be taken to choose out the soberest and most intelligent persons, whose fidelity and attachment to the service of the Company can be most relied on, and all persons instructed in the business of the Laboratory, shall first receive an order of the Governor, and Council, Major Lawrence, the Chief Engineer, or if absent the Officer Commanding the Companies, to be so instructed, and shall then be personally employed in the actual making and preparing all sorts of Fireworks, and for greater certainty that no part thereof is concealed from them, the Director of the Laboratory is to enter fair into a book, all receipts of compositions, titled with the uses for which they are designed, with the manner of compounding, preparing, fitting and making up all parts of Military Fireworks, whether compositions, machines or cases, and the said book shall be an Office book, to be inspected by all such as are ordered or permitted to attend the Laboratory as above and are willing to be instructed therein, and the Governor, Major Lawrence, the Chief Engineer, or if absent the Officer Commanding the Companies shall each of them have a duplicate of the said book, but no other copies either in part or whole shall be given to, or taken by any other person whatsoever.

29th. When Labourers are required to work in the Military Magazines or Laboratory, they shall be taken from the Company of Artillery only, and such labour shall be deemed as tours of duty, and in extraordinary cases where the labour may exceed the duty of the rest of the Garrison, such a compensation shall be made to the persons so employed as the Governor and Council shall judge equitable and reasonable, and the Council is to act in the same manner with regard to

Digitized by Google

any Artificers belonging to the Company of Artillery when employed as such, in the service of the Artillery.

30th. The Officers of the Company of Artillery are to take care to teach all persons belonging to the said Company in the practice of Gunnery in general, as the manner of serving and firing all sorts of pieces of Artillery, whether designed for the throwing of shot, shells, stones, grenades, carcasses or other Fireworks, they are to teach them the use and construction of all the instruments used for pointing or levelling great guns, or mortars, and to exercise them at convenient times in the hitting marks, whether point blank, or at any degree of elevation, together with quick firing, for which a proper quantity of Ammunition is to be allowed, they are likewise to instruct them in the making gabions and fascines, with the manner to use them in making batteries or breast-works, as also the manner of making intrenchments, whether for defence or approaches, and they are likewise to teach them the manner to mount or dismount cannon or mortars, and to remove them from place to place, at which they are to be exercised at proper times, but so as not to over fatigue them, or give them a disgust to the service, but the knowledge of this exercise is necessary as in time of danger, no other assistance can be got to do this work.

31st. The Artillery Company is likewise to be taught and perfected in the Military exercise of small arms in all its parts, in the same manner the other Companies are taught, and is to be reviewed and exercised in common with the rest of the Garrison towards the end of each month, they shall likewise go through a general exercise of the Artillery once in each month, at which the Governor or some one of the Council, Major Lawrence, the Chief Engineer, or if absent the Officer Commanding the Companies shall be present, and twice at least in every year they shall perform a general exercise to fire at marks, and throw shells in presence of the Governor or second, Major Lawrence, and the Chief Engineer, and to encourage such who perform the best, the Council may order suitable premiums.

32d. The Company of Artillery is to do garrison duty in common, and in proportion with the other Troops, and so many Officers and Gunners are to mount daily as may perform the duty on the platforms and bastions, as was done by the gun-room crew heretofore, and in all respects the Com-

Digitized by Google

pany of Artillery is to be employed as is practised in His Majesty's garrisons of Gibraltar and Minorca.

33d. No deserter from any nation whatsoever is to be entertained in the Company of Artillery, not even a British subject, who may have once deserted from His Majesty's or the Company's service, although he may have been pardoned for his desertion, nor any Roman Catholic, and if any person belonging to the Company of Artillery marry a Roman Catholic, or his wife become a Roman Catholic after marriage, such person shall be immediately dismissed from the Company of Artillery, and be obliged to serve the remainder of his time in one of the other Companies, or be removed to some other of the Company's settlements to serve it out there, if the Council think fit.

34th. Captain Delavaux with the approbation of the Governor shall regulate the clothing for the Artillery, which is to be of blue cloth out of the Company's warehouses, with red cuffs and facings and brass buttons, with a cap or hat, which shall be provided by the Captain and paid for by the Company in the same manner as ordered in the 22d and 23d articles of the Military Regulations, and the said Company shall be armed in the manner most suitable to the climate, and the nature of their services.

35th. The Company of Artillery is to be paid in the same manner by the Military Paymaster as directed by the 17th, 18th, and 19th Articles of the Military Regulations.

36th. In case of the death of any person belonging to the Company of Artillery, the effects of the deceased are to be taken care of as directed in the 25th Article of the Military Regulations.

37th. The Commissioned, Non-commissioned Officers and Gunners belonging to the Company of Artillery are to be promoted, broke, punished or confined according to the several Regulations made for the Military in the Company's service at Fort St. David, with this distinction, that where an Officer or Gunner belonging to the Artillery is to be tried, so many of the Officers belonging to the Artillery as conveniently can, shall be of the Court Martial, and in all tours of duty, the Officers of the Companies and of the Artillery Company are to roll together according to their ranks and seniority, so far as is consistent with the nature of their different servi-

Digitized by Google

ces, and are to have the same Military honors done them, and those who serve in the Artillery may be promoted in the other Companies in case of vacancies, as may those who serve in the other Companies be promoted to vacancies in the Artillery Company, but not unless they have made themselves completely masters of the business and service of the Artillery in all its branches, and give good proofs of their knowledge and experience therein to the satisfaction of the Governor, Major Lawrence, Chief Engineer, or if absent the Officer Commanding the Companies.

38th. All the posts where cannon or mortars are mounted or intended to be mounted, shall be visited once in every week or oftener by one of the Commissioned Officers belonging to the Company of Artillery, who is carefully to inspect the Artillery at those parts, that the Ordnance with their carriages and other appurtenances be kept in the best order, and if he observes any damage, decay, waste or embezzlement therein, whether from neglect, the injury of weather or other causes, he is to make immediate report thereof in writing to the Major, who is to acquaint the Governor therewith, that such damages or waste may be forthwith remedied, and means used to prevent the like for the future. He is at the same time carefully to observe if there be any damage or decay in any of the Fortifications or works, and to make report thereof in like manner through the Major to the Governor, that they may be forthwith repaired.

39th. The above Regulations are to be strictly complied with in every article, and made public in such manner that no one may be ignorant of their contents so far as he is concerned therein, and as it may be proper to make further regulations for the Company of Artillery at Fort Saint David, than can at present be foreseen, more especially with relation to Detachments sent to the subordinate Garrisons, or on Parties, it is hereby left to the discretion of the Governor and Council, with the advice of the Major or Officer Commanding the Companies to make such further regulations, which they may from time to time amend or alter for the good of the service, provided such further regulations, alterations or amendments be not contrary to, or inconsistent with the above regulations.

It is ordered that the Company of Artillery in the East India Company's service, consist as follows.

Digitized by Google

To reside where the Company's service may require.

1 First Captain and Chief Engineer at £200 per annum.

To resi le at the chief Settlement or its Subordinates.

1 Second Captain and Second Engineer	150	0	0	
1 Captain Lieutenant and Director of the Laboratory.....	100	0	0	
1 First Lieutenant Fireworker.....	75	0	0	
1 Second do.	60	0	0	
1 Third do.	50	0	0	

	s.	d.		
4 Serjeant Bombardiers at.....	2	0	per day	each.
4 Corporal Bombardiers..	1	6	„	„
100 Gunners.....	1	0	„	„
2 Drummers.....	1	0	„	„

115 men exclusive of the Chief Engineer.

(Signed) Richard Channy.
(„) H. Gough, &c.

London, 17th June, 1748.

APPOINTMENT OF BENJAMIN ROBINS, ESQ. AS ENGINEER GENERAL, AND COMMANDER-IN-CHIEF OF ARTILLERY.

No. 15.

Our President and Council at Fort Saint David.

1. Being determined to have our Possessions and Estate put in as perfect security for the future, as we are able, by making such additions to, and alterations in the Fortifications and works at our several Settlements in the East Indies, and the Island of Saint Helena, as may render them defensible against the attacks of any European or Indian enemies, we have in order thereto, appointed Benjamin Robins, Esq. in whose integrity and capacity, we have an entire confidence, our Engineer General, as likewise Commander-in-Chief of the Artillery, and that you may be fully apprized of our intentions in employing him, we have here inserted his instructions, and we direct that every article in them, so far as they relate to Fort Saint David and its subordinate Settlements, be as fully complied with, as if they were particularly addressed

Digitized by Google

to you, and we further recommend and direct, that in any matters which may have been omitted in these instructions, you give him all possible assistance and furtherance, and we particularly direct, that if any doubts shall arise about the meaning or import of any of the articles contained in these his instructions, he himself, as best acquainted with our intentions, shall be appealed to for the sense of them.

TO BENJAMIN ROBINS, Esq.

"We the Court of Directors of the United Company of "Merchants of England, trading to the East Indies, having "by Commissions under the Company's seal, appointed you "Engineer General of all our Settlements in the East Indies, "and our Island of St. Helena; as likewise Commander-in-"Chief of the Artillery during the time of your stay at any "of our Settlements or places, and of all persons, intended "for its service; you are therefore to proceed on the ship "*Grantham*, now bound to Fort St. David on the coast of "Coromandel, and observe and follow the undermentioned "instructions, and all such others as we shall at any time "hereafter think necessary to give you."

1. "You are to proceed first to Fort St. David, next to "Fort St. George, next to Fort William in Bengal, next to "Bombay, and are to call at St. Helena in your return to "Europe, and if, in your passage from one of these places "to another, you can without too great a loss of time, call in "at any other of our subordinate Settlements on the coast of "Coromandel or Malabar, you are permitted in that parti-"cular to be guided by your own discretion, but we particu-"larly recommend Vizagapatam to your attention."

2. "In all these places you are carefully to examine the "Fortifications, and to take an exact plan of the present "works, after which you are to form a scheme of such ad-"ditions or reparations as shall on the consideration of all "circumstances appear to you to be most expedient. Two "copies of this plan and scheme you are to send to us by the "two first conveyances, together with the nearest estimate "you can form of the expense, you are besides to transmit to "us at the same time such descriptions and explanations, as "may the better enable us to judge, both of the present con-"dition of the place, and of the advantages of the alterations "proposed, and are to remark every circumstance, that may "occur to you for facilitating the execution of your plan— "and for the better directing of your judgment in all these

Digitized by Google

" matters, you are to have free access to all books and " papers in the custody of our Governors and Council, " where any deliberations, resolutions, projects, estimates of " accounts relating to our Fortifications are entered."

3. " By our orders of the 17th June 1748 (copies or " which are herewith delivered to you) We have made a new " Regulation of our Military Force, and have directed the " establishment of a Company of Artillery at Fort St. David, " Fort William and Bombay, and we being desirous that our " Artillery, on which the security of our Settlements so much " depends, may be in the best condition possible, do appoint " you to examine how far these new Regulations of the " Artillery have been executed ; We therefore direct, that, " without any pay or profit thence arising, you during the " time of your stay at any of our places shall have the chief " command of the Artillery therein, and of the persons in- " tended for its service, whether they form a company, a " gun-room crew, or by whatever name they are distinguish- " ed, these you are to see trained to the use of cannon and " mortars in the manner you shall appoint, and you are to " allot what quantity of Ammunition you judge necessary for " that purpose, and you are also to form a plan for this exer- " cise, which you are to deliver to the Governor or chief at " your leaving each place, and which is punctually to be fol- " lowed by the Officers of Artillery, till other directions shall " be given by us."

4. " You are besides to examine the small arms, cannon, " mortars, carriages, ammunition and Military Stores of every " kind, which are in any of our Magazines in the places " where you shall be, of all these you are to make exact in- " ventories, noting what part is decayed, unserviceable or de- " fective and what changes or additions are necessary to be " made, either at the places or stores, for the better defence " of the place. Two copies of these inventories or remarks, " you are to transmit to us by the two first conveyances ; in " taking these inventories you are particularly to observe " if our instructions of the 17th June 1748, with regard " to the accounts to be kept by the Storekeeper, be " punctually complied with, if they are not, you are to de- " liver to the Storekeeper a copy of your own inventory, and " are to direct him in the manner of entering his future " receipts and deliveries. And you are expressly ordered " to declare to him, that our directions for the keeping these

Digitized by Google

" accounts, and the transmitting copies of them Home, shall " be rigorously followed for the future in every Article."

5. " And we hereby empower you to suspend or dismiss " any of our Officers or private men in the Artillery, that you " shall think unfit for our service, transmitting to us the rea- " sons of the suspension or dismission of any Officer as afore- " said, and you are to appoint other Officers in their stead, " until our pleasure is known."

6. " If during your stay in India, any of our places should " be threatened with an attack, either from an European " enemy, or from the troops of the country, we in that case " leave it to your discretion to repair to such of our Settle- " ments, where either from the neighbourhood of the enemy, " or from other considerations, you shall conceive your advice " and assistance, may be of most advantage to our interests, " and on all these emergencies, we shall direct our Governors " and Council, that they shall admit you to be present, and " to vote at all consultations, where any Military proceedings " are considered."

7. " In all our places that you shall visit (except Calcut- " ta in Bengal) we choose that you should avoid any great " and expensive work till you have our further directions, " but where the delay is apparently mischievous, and where " you are fully satisfied in your own judgment, we authorize " you to direct immediately what reparations or changes shall " be made, either in the fortifications, the warehouses, the " Artillery or in any other article connected with the defence " of the settlement, having a particular regard, that the ware- " houses, if possible, may be situated in convenient and secure " places within the Fortifications, and the Magazines secure.'

8. " And, to avoid the unnecessary expence which con- " fusion and mismanagement may occasion in the works you " may carry on in consequence of these, or of our subsequent " instructions, you are empowered in all cases to appoint " inspectors at each working place, over each branch of " work, these are to have an eye upon the work, and are to " take a daily account of the number of workmen employed " under them, and no payments to workmen shall be allowed " to the Paymaster, but corresponding to certificates of these " inspectors, examined and countersigned by yourself, we " further direct that you appoint two joint inspectors to be " present at the delivery of all materials and the Paymaster

Digitized by Google

" shall not pay for these materials, but on the joint certificates " of these inspectors examined and countersigned by you; " of all these certificates you are to keep copies by which you " are to examine the Paymaster's accounts, which he is to " deliver to you every month, and if upon this examination, " or for any other reasons you are dissatisfied with his con- " duct, you are to require the Governor to remove him from " his office of Paymaster, which requisition of yours, the " Governor will be directed to comply with, and if any per- " son employed in the works, whether our own servant, or " an Artificer of the country, does not behave to your satis- " faction, you are authorized to remove him from his employ " in the works, and if he be our Covenanted Servant you are " to certify to us, the reasons for which you displaced him."

9. " As we are resolved to throw up some works about " the Town of Calcutta, for the better defence of its inhabit- " ants, agreeably to our letter of the 17th June 1748, a copy " of which is herewith delivered to you, you are therefore on " your arrival at Fort William to consider of a plan for that " purpose, in forming this plan you are to endeavour, that it " may be of such a nature, that without any material change " in the general disposition and without demolishing the " works that will first be raised, the whole may afterwards be " wrought into a more complete fortress; when after mature- " ly weighing all the circumstances necessary to be considered, " you have formed your plan for the works about Calcutta, " and have made an estimate of the time, expence, materials " and workmen necessary to complete it, and have determin- " ed with what part to begin, and in what order to proceed, " you are then to lay the whole before our Governor and " Council, and to require them to prepare the money, mate- " rials and workmen, and to issue the proper orders for carry- " ing on the work, which requisition of yours they will be " directed to comply with."

10. " That you may be the better enabled to execute the " various articles contained in these instructions, we have " sent with you Mr. John Barker, Nathaniel Carrington, " Charles O'Hara, Sampson Morrice, Charles Knapton, and " Philip Glass to be your Assistants, all whom are to be there- " fore entirely under your directions, to be employed as " you shall order, and for their diet we direct that twenty " pounds sterling per month be allowed you over and above " the appointment in your contract, but as the said allowance

Digitized by Google

" is calculated for six persons, therefore a proportionable " abatement is to be made in case of the death or dismission " of any of them, and we farther allow Mr. Barker forty " pounds sterling per year, and each of the others twenty " pounds sterling per year by way of salary, till such time " as you quit them on your return to Europe, after which " they are to be entertained in our service, on the same foot- " ing as our other servants in the like rank that is to say, Mr. " Barker to take his standing as a Factor, from the time of " his first landing in India, and the others to take their " standings as Writers from the same time ; on your return " to Europe you are to leave them in such of our Settlements, " where you think they will be most useful, we reserving to " ourselves the power of fixing them afterwards either in " Bengal or on the coast of Coromandel or Malabar, if besides " these persons you carry with you, you shall think it neces- " sary in any of our places to have the assistance of any other " of our servants or officers, you are empowered to make use " of them in the manner you shall find most expedient, pro- " vided if they are above the degree of Writers it be with " their own free consent—and every one of our Covenanted " Servants thus employed by you shall not thereby be depriv- " ed of any of the advantages of rank, pay, allowance or ad- " vancement, which he would have been entitled to other- " wise."

11. " If you are obliged to leave any of our places, before " the works you have begun are completed, you are autho- " rized if you think it expedient, to leave one or more of your " Assistants behind you, whom you are fully to apprize of " the nature of your design, and of the manner in which you " intend it to be executed, those whom you thus leave, are to " keep a regular journal, in which they are to enter daily, " the quantity of materials received, the number of workmen " employed, the payments made, and the progress of the " work, for which purpose they are to have free access to all " parts of the works, and to all accounts and papers relating " thereto, and if at any time they observe that the work is not " carried on conformable to your plan, or that there are any " irregularities in the payments, or misconduct in the work- " men, they are to make their complaints in writing to the " Governor and Council, and are to pray that proper orders " may be given for the remedy of those abuses, copies of all " these complaints they are to enter regularly in their jour- " nal, which journal is afterwards to be delivered to you, and

Digitized by Google

" by you to be transmitted to us, reserving a copy for your " own use, you are during your absence to allow each of " your Assistants for diet money three pounds, six shillings " and eight pence sterling a month, over and above their " salary, and as an encouragement to them to behave faith- " fully in this employment, you may assure them that on " your representing to us their fidelity and diligence, they " may depend on being considered by us in the manner their " services shall deserve, but if contrary to our expectation, " any of them should upon these or other occasions fail in " the integrity, or assiduity expected of them, you are em- " powered to remove them from their employ, and to send " them to Europe by the first convenient shipping, certifying " to us at the same time the reasons for their dismission."

12. " That the works begun or projected by you, may " not be interrupted by any casualty that may happen to " you, we direct you to draw your designs upon a large scale, " and to be very explicit in your description of their differ- " ent parts, and if, from the particularity of the construction, " there are any works intended, where it may be supposed " that drawings are not alone sufficiently instructive, you are " in that case to cause large and durable models to be made " of them, which models together with copies of your plan, " and all the descriptions, directions and estimates relating " thereto, you are to deposit with our Governor and Council " of the place where the works are to be carried on.

13. " You are carefully to correspond with us, and to " inform us of the progress you make, and of the manner in " which your different employments are executed, and of the " behaviour of those we send out under your direction, and " as you are furnished with proper instruments, you are to " take all fitting opportunities to observe the longitudes and " latitudes of such places as you shall visit, and likewise the " variation of the compass as often as you conveniently can, " and when you are not immediately busied in our other " services, we expect that you should not omit pursuing any " enquiries which may occur to you, that may tend either " to the improvement of Geography and Navigation, or to " the advancement of other branches of useful knowledge, or " to the support and enlargement of our commerce and in- " terests in the East."

14. " We have provided several mathematical instruments

Digitized by Google

" and other particulars for your use, according to the enclosed " list, which on your departure from India are to be deliver- " ed to the Governor and Council at any of our Settlements " as may be most convenient to you."

II. The same Civil and Military honors are to be paid to Mr. Robins as to the third in Council, and as you value our future favor, you and all our servants in general are, as well in your private as public capacity to behave in such a manner to him, as may facilitate the execution of his plan.

III. Mr. Robins is under covenant with us to continue in India until the dispatch of the last ships from the place where he shall be resident between the months of January and March 1753-4, and if he loses his passage outward-bound he is to continue in India until the same time in 1754-5. During the time of his stay at your Settlement you are to pay him for his own and his menial servant's subsistence, and instead of diet money, after the rate of ten pounds sterling for every calendar month, to commence from his first arrival at any of the Company's Settlements.

IV. Which as well as the several allowances mentioned in the before going instructions, are to be computed and paid at the rate, We permit Bills of Exchange to be drawn upon us on account of our Covenanted Servants.

V. Upon removing from your Settlement to another, you are to certify to what time Mr. Robins and his Assistants have been respectively paid their said allowances, and in failure of such certificate, the Governor and Council of the place where they are resident shall be governed in their payments thereof, by a certificate to that purpose under the hand of Mr. Robins.

VI. Over and above the allowances aforesaid you are to discharge all the expences he shall be at for himself, assistants and servants in going from place to place, by sea or land, as well as all extraordinary expences incurred by him in the execution of the trust we have reposed in him, which said expences not having been otherwise before paid him, are to be paid on his certifying the particulars to you under his hand.

VII. That we may have a full and distinct view of all the charges and expences that will attend the carrying our Engineer's schemes into execution, they are to be carried to account under a new head, to be erected in your books for that purpose.

Digitized by Google

VIII. You are to provide for Mr. Robins and his Assistants a convenient apartment or house in the Fort or elsewhere, as may be most conducive to the service, and agreeable to him.

IX. Upon Mr. Robins' discharging his Assistants on his return to Europe, and there being thereupon in consequence of the 10th para. of his instructions to be on the foot of Covenanted Servants, they are then to enter into the usual covenants, and write to their friends in England to give the customary security.

X. We observe that Thomas Heath whom we sent out a writer to be trained up under Mr. Delavaux, is represented as not having a turn to the profession of an Engineer, and is therefore stationed under the Accountant at Fort St. David, we direct that Mr. Robins have a trial of him, and if he finds him incapable or unwilling to assist him that he be sent Home on one of the first ships.

XI. The several mathematical instruments, and other articles provided for the service of the Engineer, are to be left with the Governor and Council at any of our Settlements as may be most convenient to him on his departure from India.

XII. We have appointed Robert Barrowcliffe, a smith, and Israel Selfe, a carpenter, to proceed with, and be under the direction of our Engineer, they have contracted to serve five years from the time of their landing at any one of our Settlements, from which time they are to be paid sixty pounds sterling per annum, each in full for their respective services, when Mr. Robins leaves India, they are to serve the remainder of their five years where they may be most useful to the Company, you are to be governed as to the rate of exchange, and the manner of paying them according to the directions we have given with regard to Mr. Robins and his Assistants in the preceding part of this letter.

We are,

Your loving Friends,

(Signed) W. Baker,
(„) Richd. Channey,
(„) R. Drake, &c. &c.

London, 8th December, 1749.

Digitized by Google

PETARRAHS FOR BANGHY PARCELS.

Letter from Lieut. H. CONGREVE, *Madras Artillery, to the Post Master General, Madras, dated Tutocorin, 4th June* 1838.

Actuated by a notice which has lately appeared in the public prints of the Presidency, intimating the desire of the Supreme Government, that some method should be obtained by which the Petarrah used for the conveyance of Banghy parcels may be rendered water-proof : I have the honor to forward for your consideration, a few observations, and suggestions for compositions impermeable to water ; along with *ten* plans for an improved vehicle for the conveyance of the letters, packets, &c. If you are of opinion that any of these may prove serviceable, I request you will have the goodness to take such measures as you may deem most expedient to put them to the proof, and forward them to higher authority.

The Petarrah in use at present, I believe consists of a square wicker basket, and the only precaution taken to guard against wet, I think, is one or two folds of wax cloth, as an envelope : before I enter into a description of what I consider improvements upon this, which as it stands at present, has nothing to recommend it further than its portability; I shall take leave to lay before you a list, with a concise account of some of the most common water-proof substances, which has as yet come to light, and as I proceed, I shall endeavour to show in what manner they may be made to answer the end in view. The vegetable gums or resins offer a very wide field for choice, in the preparation of a solution for washing skins, cloth, &c., so as to render them impervious to water: amongst these the first in order is

CAOUTCHOUC OR INDIAN RUBBER,

which is the viscous juice of a tree belonging to the family of Euphorbia, and which, within these last few years, has been ascertained to flourish in Assam, Ceylon, and other parts of the Indian Empire. This substance, after being properly prepared, is capable of being made use of in a variety of ways, as a defence against wet, owing to its peculiar softness and elasticity, and not being subject to the action of air, water, or indeed the greater number of the chemical agents. The solution of Caoutchouc in any of the vegetable oils may be

Digitized by Google

used with the greatest effect as a varnish for *washing* the Petarrah.

Amongst other vegetable productions the different kinds of resins and gums may be turned to account, by mixing them up into a dammer with cocoa-nut or other vegetable oil, as a varnish for the cover of the Petarrah; and there are certain leaves, and barks of trees, upon which water has no power of resting, but rolls off in large globules, as it would down the side of a piece of wax or grease. Cork ranks next to the resins, but its properties are too well known to need description here.

Stick lac, seed lac, lump lac and shell lac, are all vegetable juices partaking in some degree of the properties of Caoutchouc.

ANIMAL MATTERS

next fall under notice, but they are so numerous that I shall merely subjoin a list of a few of them, without entering into an account of their several qualities, further than remarking that those that are noticed may be made use of in preparing the water-proof Petarrah.

The wings of birds in all probability furnish the best example of an arrangement of animal matter as a security against wet, and we are taught to look upon oil as a specific almost, from the curious circumstance of the feathered race being furnished with glands full of it, near the inner extremity of each wing, from which they are enabled to take their flights in the heaviest rain, by anointing the coverts of the wings with the contents of that little magazine.

LIST OF ANIMAL MATTERS IMPERMEABLE TO WATER.

Horn cut into sheets.
The cured gut of animals.
The coat of the bladder.
Seal skin.
Shark's skin.
Elephant's skin.
Parchment.
Cow's skin.
Deer skin.
Elk skin.
Turkey's maw.

Digitized by Google

Sheet tin.
Sheet copper.
Sheet lead.
Talc.
White lead mixed with oil.

The following compositions are offered as varnishes for the covers of the different kinds of Petarrahs, which will be immediately described : they are all warranted water-proofs.

COMPOSITIONS.

1st.

Solution of Caoutchouc in Cocoa-nut oil,

2d.

Dammer, of Shell-lac and Cocoa-nut oil.

3d.

Turpentine, Lime, and Cocoa-nut oil.

4th.

Pitch..... 5 parts.
Resin .... 6 „
Tallow.... 1 „
Bees' wax 5 „

5th.

Shell lac.. 2 parts.
Wax Bees' 2 „
Tallow..... 1 „

6th.

Glue common 6 parts.
Oil..... 1 „

7th.

Glazier's putty.

Having now shewn several different compositions, I shal proceed to explain ten plans of an improved Petarrah, to any one of which those mixtures are applicable.

Plan 1*st.*—I would here suggest that the basket be furnished with quadruple covers shutting over each other, but in direct contrary ways—so that in whatever position the Petarrah is held, there will always be a roof with overlapping sides

Digitized by Google

uppermost: no water in this case can possibly find a passage to the interior, unless the flaps were so close as to admit of a capillary rise; but this is more than improbable, and even if it did take place, the vertex of the parabola of fluid would never attain the top of the flap's side—these four covers should be made of osier work of the lightest description, covered with cloth well saturated in the Caoutchouc solution, or parchment, or oil-cloth, or a skin of Indian rubber itself, or any of the foregoing water-proof substances. Or in place of the wicker work frames, thick oil-cloths may be substituted, bent into the proper shape and well joined at the corners.

To make security doubly sure, it might be advisable to fasten a curtain of water-proof cloth to the interior of the outer cover and half way down its inside; when this is drawn tight and fastened below, it is the most perfect safeguard against the passage of water to the interior.—Plate 63, Fig. 1.

As the above drawing illustrates the position of the four covers in relation to each other, it is necessary to add another, to shew the situation of the curtain.—Fig. 2.

It will be very evident that no water can rise between the two outer cases, as the water-proof curtain running across the space between them, entirely precludes its admission.

Plan 2d.—A double sided basket with a double sided roof or cover, the hollow space between the double side to be stuffed with sheet cork.—Fig. 3.

The exterior of the Petarrah to be covered with water-proof cloth.

Plan 3d.—A light tin box with sliding cover, the slide uppermost; the whole to be enveloped in a water-proof folding, tying below: the interstices between the folds of the tie to be filled with putty or sealing wax.—Fig. 4.

Plan 4th.—A common case or basket, or one of the preceding plans, guarded from the weather, by an umbrella roof of any of the water-proof substances. The end to be bell-shaped, that in the event of the apparatus falling into a river, it will float on its base without the inside getting wet, and should it sink, the inward air, like that in the Diving Bell, will prevent the ingress of water to the detriment of the enclosed Petarrah.—Fig. 5.

The side of the bell to increase in weight and thickness as

Digitized by Google

it descends, and the case inside to swing on hooks, to ensure the centre of gravity and the line of direction being about the lowest point; in order that the umbrella, if it happens to fall, may always descend on its base.

Plan 5th.—A light wooden deal box of a cylindrical shape and bored out of one piece of wood opening, with a screw top; the threads of the screw to fit tight and be occasionally washed with Dammer No. 3, made rather softer than before prescribed: the whole to be enclosed in a water-proof cover of skin or any other of the described substances, fastening underneath and defended by former precautions.—Fig. 6.

Plan 6th.—A Petarrah whose frame work is made of light wood or osier and glazed oil cloth; the cover to have a double edge and lined with green baize; the lower half of the box to have a single edged rim to fix into the groove of the upper half; this rim should also be covered with baize, the glazed oil cloth to hang down from the base of the roof of the cover, and to tie underneath the whole. N. B. The serrated edge follows the circumference of the basket which is circular. —Plate 64, Fig. 2.

Plan 7th.—A basket covered with the scaly coat of the Indian Ant-eater, or that of the Alligator; whereby a *tiled* roof is obtained for the Petarrah.—Fig. 3.

Plan 8th.—A cylindrical box made out of one piece of wood, with a thick leather plug, or bung, or cork, which screws down *hermetically*, to any degree of tightness.—Fig. 4.

A bar to run through the rim of the box, to answer the purpose of a fulcrum for the screw, which plays through the threads of a female one bored in it; the screw is cleated to the bung, by a nut and bar below.

A water-proof cover lies over the upper half of the case.

Plan 9th.—A tin case with double cover and curtains made of any of the water-proofs.—Fig. 5.

It must be very evident, on looking at the diagram, that not a single drop of water could make its way to the packets in the case, as the cross curtains made of a water tight material connect the sides of the boxes together, the covers fit closer together than above represented. I have left so broad a space, to show the principle as clearly as possible. I consider this the best plan of the whole.

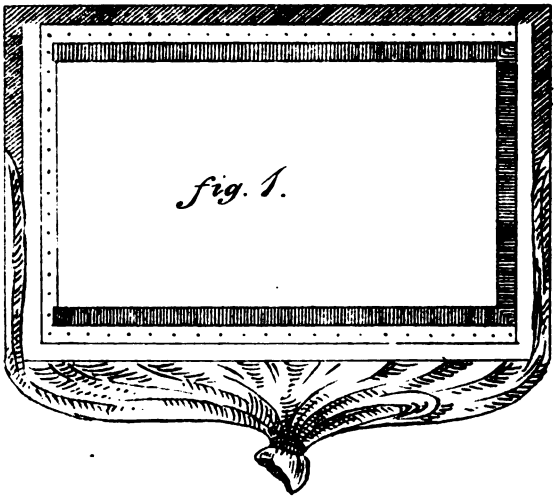
Plan 10th.—A double bag of Caoutchouc, moulded on a

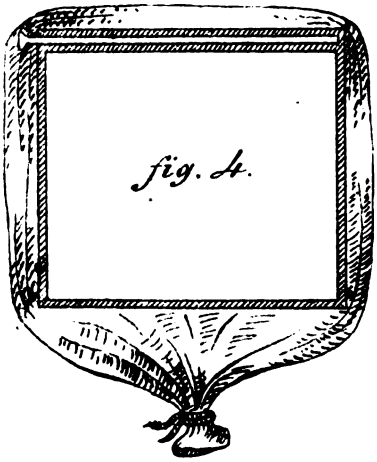
Digitized by Google

Digitized by Google

Water-proof Petarrahs

Lie







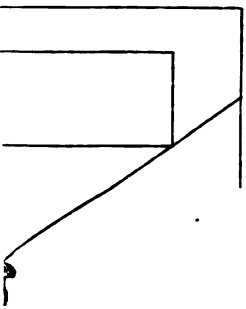
Art V. Depôt lith.

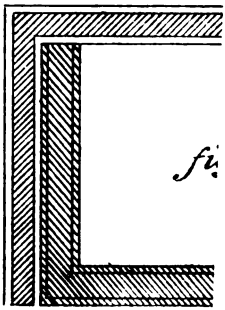
Digitized by Google

neous.

veyance of Banghy Parcels,

greve.

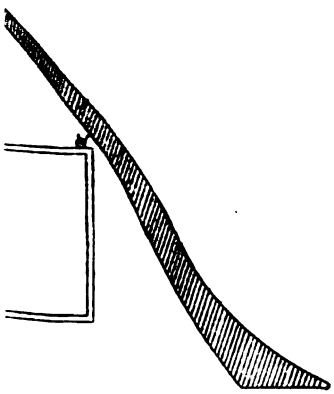


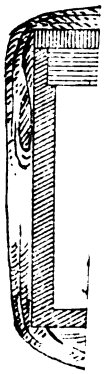


fi.

2.

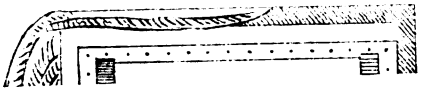
5.





Digitized by Google





Digitized by Google

Digitized by Google

Water-proof Petarrahs for th
Lieut.

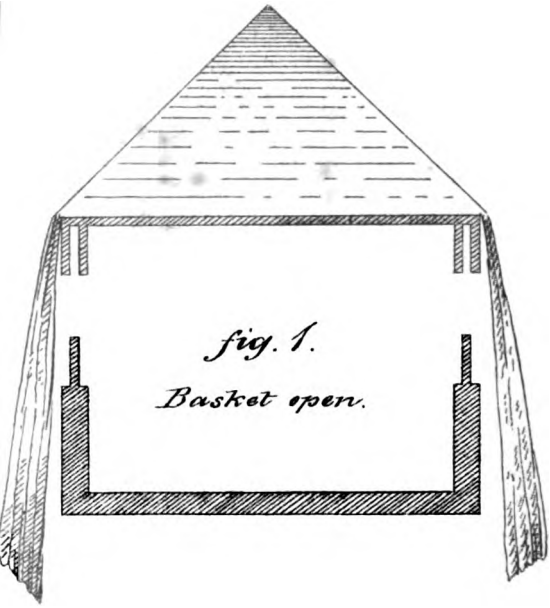


fig. 1.

Basket open.

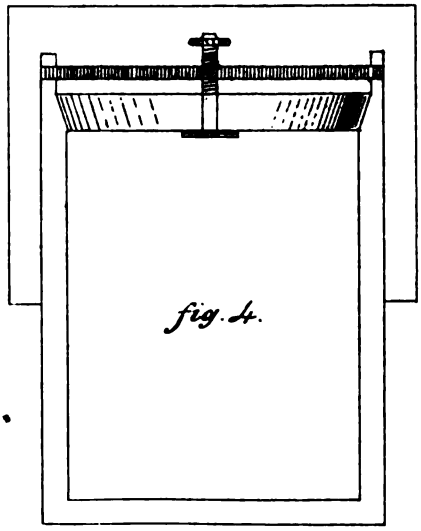


fig. 4.

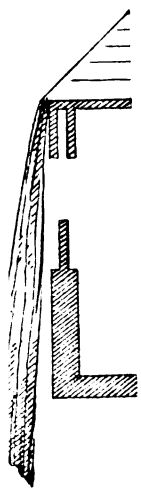
Art.y. Depôt lith.r

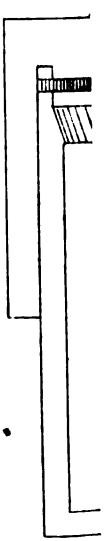
Digitized by Google

ous.

of Banghy Parcels by
ve.

Digitized by Google





Digitized by Google

globe of pottery; the neck of each circular bag to project through the bottom of the other, or rather, a small portion of it; to retain the two bags in their proper relative positions, this, however, may not be necessary at all.—Fig. 6.

As you may perhaps be averse to interfering with the trial of these plans, before they have been laid before the Supreme Government, or Post Master General in Bengal, by whom the advertisement proffering the reward for the discovery of that which they aim at, was, I understand issued, I will thank you to forward them, as soon as you possibly can, to Calcutta, that no one may anticipate me in the application of the principles, for an improvement upon the Petarrah, which I have herein brought forward.

In conclusion, I beg you will have the goodness to favor me with a few lines in reply to these, informing me of the nature of the opinions upon the subject-matter of this letter

Letter from Lieut. CONGREVE, *Madras Artillery, to the Post Master General Madras, dated Tuticorin, 17th June,* 1838.

In continuation of the subject of my last communication regarding an improvement on the Banghy Petarrah, I have again the honor to address you.

The enclosed is another plan for the basket, combining the principles of one or two of those previously advanced; and with it, I offer a composition, which I apprehend is but little known, though employed for the purpose in question almost universally in China. It may be prepared of any degree of elasticity, and consistency, and I think will be found of material service in perfecting the basket.

I request you will have the goodness to forward this letter to Calcutta, to the Post Master General of the Bengal Presidency there.

Plan 11th.—Consists of a case manufactured from any of the previously described materials, with four covers shutting over each other, all in opposite directions, with curtains crossing diagonally, the void spaces between their respective sides, and fastened below to any degree of tightness by leather straps e a buckles. The curtains to be made of Caoutchouc cloth, or leather well saturated in any of the water-proof substances or rather mixtures. The outlined, elevation of the basket it is hoped, will sufficiently illustrate the principle. It is not

Digitized by Google

of course intended that the basket itself should possess spaces like those shown in the drawing; on the contrary each cover fits closely over the collateral one: the contrivance thus becomes a perfect labyrinth, if the term may be here applied, and it is rendered wholly impermeable to water, air, or any other chemical agent, excepting fire. The double sides in the diagram point out the surfaces under which the straps are drawn and fastened, and they should be as flat and lie as compact as possible. A pyramidical or conical roof may surmount the outer cover, to divert the rain.—Fig. 7.

I annex a notice of the ingredients of the celebrated Chinese water-proof preservative; and as the materials are easily procurable, it might be worth while employing it for the end in view.

The Chinese water-proof elastic preservative, is nothing more than a compound of the thickest description of castor oil and chunam thoroughly amalgamated; it may be, by the addition of either of the ingredients, brought to any degree of consistency, from the water-proof wash proper for the exterior of bags, boxes, &c. to the thick elastic India rubber-like substance, which in itself is a fortification against the attacks of anything extraneous or external which may threaten to injure whatever it may have behind it.

CORRECTION OF AN ERROR IN THE SKETCH OF THE BATTLE OF MEEANEE.

Letter from Brevet Captain ROBERT HENDERSON, *Madras Engineers, to the Adjutant of Artillery, Madras, dated Camp Kuratchee, 24th October* 1842.

In the plan of the Battle of Meeanee* which accompanied my letter of the 25th February last, the 1st Bombay Grenadier Regiment is represented in rear of the 12th Bombay N. I. in which I was guided by information received at the time. From subsequent information however it appears that such was not the case, and that the proper position to be assigned to the 1st Grenadier is on the left of the 12th N. I. I beg therefore in justice to the Grenadiers, that as my former letter and plan were published in the Madras Artillery Records, this letter may also be sent to the same periodical for publication.

* Page 403 and Plate 58.

Digitized by Google

REMARKS ON THE CONSTRUCTION OF LIGHT FIELD CARRIAGES BY MAJOR ANSTRUTHER, C. B.

Letter from Captain and Brevet Major P. ANSTRUTHER, C.B. *Horse Artillery, to the Director of the Artillery Depôt, Saint Thomas's Mount, dated Bangalore, 6th October* 1843.

I have the honor to forward the following remarks, with three plans accompanying, for insertion in the Artillery Records, if you judge them worthy, and the Brigadier Commandant sees no objection.

In page 282 of the Proceedings of the Special Board of Artillery Officers, a note states "Details not given" of the calculations by Colonel Tennant. These are of course simple and easy, but I hope it will save some time and trouble if you will print in the Records the accompanying sketch of the trail.

The way to cut this out of the timber is shown clearly enough in page 283, but for drawing it on paper, the sketch I now send you plate 65, will certainly be more simple and convenient to any one who may have to draw Gun Carriages as frequently as I have lately been doing.

It is an elevation of the trail of the 9 pdr. and 6 pdr. gun, and 24 pdr. and 12 pdr. howitzers, with a table of dimensions in the order of succession in which it is most convenient to draw them. Perhaps the Gun Carriage Manufactory will add the weights of the Carriages, deducting the axle and axle bed, also the traversing handspike, giving also separately the weight of the elevating screw. This with the valuable information in page 299 will leave us little or nothing to desire regarding these trails.

But it will be said, these trails are already obsolete, a late order directs that the Artilleries of all India shall conform to the pattern in use with the Royal Regiment. Before proceeding to remark upon the working of this order, I will just mention, to comfort my comrades, that it is not likely long to operate to our detriment, we know that the Royal Artillery Officers who served with our Troops in China have admitted the advantages of the metal nave, ring tire and other points of difference between us, and we see that Captain Grant has lately introduced a 9 pdr. with great success, differing very slightly from what we have used during the last 8 years, we may therefore hope that the spirit of improve-

Digitized by Google

ment will rid us before long of the wooden naves and streak tires, heavy guns and great windage. Apropos, has not a newspaper error crept into the Artillery Records on the subject of this gun? It is stated that the bore is $4\frac{1}{16}$ inch. Should we not read 4·16? Can the bore be only 4·0625? Even the 9 pounder carronade has bore of 4·14 windage ·04 or ·08.

But to return—In obedience to the order to adopt the Royal Artillery pattern, we have constructed a Carriage wholly of Saul timber, and a beautiful structure it is, but we cannot drag it along.

	cwts.	qrs.	lbs.	or lbs.
The Royal Artillery Carriage for a 6 pounder weighs.....	8	3	6	986
Our copy executed in Saul wood ...	12	1	21	1393
Difference against us.	3	2	15	407
The Royal Artillery Limber weighs.	8	0	5	901
Ours, same pattern Saul timber.....	13	0	17	1473
Difference against us.....	5	0	12	572
Sum of these two differences.	8	2	27	979

These Carriages are constructed at Woolwich of Oak which we have not. The nave is of Elm, which we do not possess, the felloes are of ash, not found in India. If we are to adhere to their pattern and to build with Saul wood, we must have larger horses or more of them.

	cwts.	qrs.	lbs.
For, our carriage so built weighs.....12	1	21	
our limber.....13	0	17	
our gun..... 6	0	0	
40 rounds of ammunition..... 2	3	22	
Total..34	2	4	

Now 6 English horses are allowed to be able to draw 30 cwt. and 8 English horses to draw 36 cwt. I think it evident that 8 Arabs or Persians to $34\frac{1}{2}$ is less than proportionably sufficient—I have omitted the two men on the limber, and all side arms, small stores, &c. so that I am sure the calculation is within the mark—By the bye, the Bengal Members in this same calculation put down carriage *and*

Digitized by Google

limber as 13 cwt. vide page 29, 1456 lbs.—But it should have been, vide page 299.....2325 „ their calculation being wrong by..... 869 „

I think I have said enough to prove the impracticability of our adopting the royal pattern carriage, for want of their wood, I will now comment on the Special Board's carriage and limber—The Board unanimously condemned the use of Teak wood in cheeks and axletree beds,—I fully concur in the letter of this decision, not in its spirit—Had they condemned the use of all wood in cheeks and axletree beds, I had agreed with them, but when they condemned the only wood procurable in Southern India, in favour of a heavier wood which will cost double what Teak does, it is worth our while to enquire if every thing had been done to minimize the bulk of the carriages to increase their strength, to avoid perforations which of necessity weaken the beams, in fact whether the failure of Teak was owing to badness of timber, or faulty construction.

Let us see how the 6 pounder carriage was constructed—assume 30 inches radius of wheel—The constructor beds his axle in a beam of $5\frac{1}{2}$ inches deep $6\frac{1}{4}$ broad—This raises the lower edge of the trail 3·1928 inches—Why? Because, he says iron axles bend under the shock of firing—But they bend because they are weak, and are weak only because they are long, the length is given only because your gun rides so high it requires lateral base—So if you shortened the axle you need not bed it in wood—A beam 11 inches deep is then laid on the axle bed, raising the trunnion centre to an additional height of 11·7047 inches, a band is passed under the axle and 4 holes are drilled right through the wood, two in front of the axle, two in rear—these holes are one inch in diameter, and the beam being 3 inches thick you have a thickness on each side of the bolt of 1 inch of wood eleven inches deep—of course this will not stand much.

The next step is to bore a hole in the trail 29 inches distant from the trunnion centre, into which an elevation screw transom bolt is inserted—When the gun is fired the portion of force producing recoil which is insufficient to raise the gun and carriage on the trail end as a centre, is still sufficient to raise the breech on the trunnions as a centre, it does so, the axle returns to the ground if it has risen, but the breech has a tendency to rise—If there be a cascable loop, it cannot rise but the force tending to raise it, is all exerted on that portion of the trail which is *above* the elevating screw transom bolt, tending to pull such upper part away from the under; if

Digitized by Google

there be no cascable loop, the breech does rise, and in falling again, it inflicts a blow on the transom tending to drive the portion of the trail underneath the transom bolt away from the upper—In either case, only half the depth of the wood is used to resist the force.

This of course gives—It is 27 inches distant from the support of the axle and 72 inches distant from the support on the ground, it is only half the depth of the wood and when it breaks, we say the wood is bad—no doubt, all wood is bad, but it has not yet had fair play—Let us see whether a carriage cannot be constructed which as it shall have a trail 3 feet shorter, with no perforations whatever, may be built with wood furnished by our own country and yet stand proof, for we will employ every fibre to resist the shock it is exposed to, not waste half the resistive strength by misconstruction.

Assume as before 30 inch radius of wheel—I would shorten the axle, if I could afford it, but as many think it a matter of importance that the gun wheels should travel in the exact track of the limber wheels, which I confess I do not, I must build a limber if I alter the span—I therefore retain in the experimental carriage I am now building, a length of axle of 44·4 inches, and this renders considerable scantling necessary in the iron of the axle, I therefore give 3 inches square bar.

On the sketch I forward, of the Special Board's trail for Field carriages, plate 66, draw a horizontal line 30 inches above the plane of ground—Where this cuts the upper side of the trail, draw a line perpendicular to the lower surface, 1½ inches in length for the rear side of the axle, parallel to the lower side draw a line 3 inches long for the lower surface of the axle and complete the 3 sides of a square by a line parallel to the first—The distance from the axle to the point U. of the Special Board's elevation (copied in mine) is 55 inches, all above the line of 30 inches high, or very nearly all, I will cut away—I will use three inch plank fortified by two transoms which however shall not cause any perforation whatever—The two cheeks of the trail shall be bolted on to the lower surface of the axle by two axle bands, secured by 4 screw nuts to a band plate passing under the lower surface of the trail—My present idea is to have the cheeks of the trail brought inside the trunnion supports, but it is possible I may see ground to alter this.

The next thing to be considered is the connecting the trunnions and axle—This I propose to do as follows.—Swing the gun horizontally—bring a 3 inch square bar as close as you

Digitized by Google

can to the under surface of the metal of the gun, parallel to the trunnions and directly under them, and measure the distance between the lower surface of the trunnion and the upper surface of the axle bar.

If the diameter of the piece at the trunnions be 7·5 and the diameter of the trunnions 3, clearly ·75 of an inch is the necessary thickness of metal under trunnions, I say *metal* for I propose to use all the iron formerly expended in weakening the cheek of the trail, to form a trunnion support of solid wrought iron—Two such trunnion supports, 7½ inches apart will make the sole connection between gun and axle—The centre of the axle is not the place where it will break I therefore will not leave the whole 3 inches square at the centre but cut out such a notch as supposing the axle's lower surface to form an angle of 20° with the horizon, will allow the gun to lie point blank.

The remaining points connected with the construction will be better understood from the accompanying drawing, plate 67, which shews my present notion of what my carriage shall be, though I am by no means sure that some alterations will not suggest themselves during the course of construction—All the pintail fittings, traversing handspikes &c.—shall be the same as now used, I will bolt the two cheeks of the trail together by bands tightened up as required with screw nuts and have no perforation whatever, except at the lower end at the trail handles, and as my trail will be much shorter, stronger and lighter, I hope it will be adopted.

If it should be adopted, it will require a limber of the old Madras pattern—The Special Board decided that the limbering hook should be attached to the axletree bed, as had been the case in Bengal and Bombay, how this has been found to answer in the other Regiments I do not know, but a fair trial has proved its unfitness for the use of our own Horse Artillery —I say for the Horse Artillery, because though the present *mania* for assimilation has fixed that there shall be no difference between the Limbers of Horse and Foot Artillery, the nature of the animal employed in draught points out that a wide difference ought to exist in the construction of the carriage.

A bullock is said to draw all the better for having a considerable weight on his neck, but it is quite the reverse with a horse, he is pressed down and jaded by a small weight placed on his neck, and our own limbering hook being placed at the end of a perch, 22 inches in rear of the axletree bed, we never found

Digitized by Google

those inconveniences which Majors Craigie, Coghlan, Pew, Grant, and Abbott, all agree in stating the Bengal Horse Artillery did find, and which they all agree in considering as conclusive of the often argued point whether pole or shaft driving is the best—All these Officers say that the pole system is very objectionable, because of the weight on the horses' neck, and for no other reason, but there is no necessity for having any weight at all on the horses' neck or back, the Madras pattern limber placed very little weight on the collar, but the Special Board's limber brings a vast additional weight on the horses' neck in pole draft, on his back in shafts.

One Madras member of the Special Board pointed out this error to his colleagues, who replied that stowing all the shot in the rear part of the limber boxes would obviate the objection, but experience has shewn that this is not the case, and the troop which was furnished with limbers of their construction has lately exchanged them for our old pattern limber, finding that the other galled the horses withers and distressed them very much, placing 161bs additional weight on each horses' neck—If I were to build a limber I would even lengthen the perch placing the limbering hook about 8 inches further back than in the old Madras pattern, so we should have hardly any weight at all on the horses' necks and the whole of the reasoning in favor of shafts would fall to the ground.

The trail being placed under the axle, instead of being on the top of it, is clearly about 3 feet shorter and if it were then limbered up to the new pattern limbering hook, fixed to the axletree bed, the wheels of the gun and limber would be so close together that the men who limbered up could not get between them—I understand the motive of the members of the Special Board for so placing the limbering loop was, that they expected greatly to facilitate draught by shortening the distance between the gun and limber wheels, my proposed shortening of the trail will effect this without throwing any additional weight on the necks of the horses, and will give us the same facility of turning in a small space as we enjoyed with the old fashioned limbers, the new pattern as laid down by the Special Board I have frequently seen lock, in fact you cannot reverse a line of guns, only 15 yards distance apart, with the new limbers—more space is required.

I will now advert to an objection which I expect will be made to this carriage by the only Officer who has honored me with a reply to my former writings, and whose opinion I am therefore more anxious if possible to carry with me, than

Digitized by Google

that of any other Officer of the arm—I mean Lieutenant Ash, Bombay Artillery.

He will probably think my carriage too light.

For, in his "Remarks on a 24 pounder Howitzer carriage," appended to Major Coghlan's letter to Secretary Military Board, 15th April 1840, we find the following reasoning.*

"The recoil and strain which a light gun occasions to its "carriage is always much greater than that of a heavier gun "of the same bore, because there is less dead weight or power "of resistance."

"The light gun therefore should not have too light a carriage."

Here Lieutenant Ash, consistent "advocate for heavy proportion of dead weight" uses the word "light" as if it were synonymous with "weak" which is not granted.

His argument stands thus—The strain is greater, therefore the carriage must not be too *light.*

I argue that it cannot be too light, provided it is strong enough, and I think he will admit that the word light here used would be advantageously exchanged for the word "weak."

If I can make the trail strong enough to resist the shock of recoil, I can always at pleasure diminish the distance the gun and carriage shall recoil to, either by placing the trunnions further in rear of the axle, if I am to build for the present faulty construction of gun, or by placing the trunnions well in advance of the centre of gravity of the gun, if I cast my own piece, on more correct principles than now obtain—either way I greatly increase the pressure of the trail upon the ground which will check recoil as it should be done, without adding to the weight my horses must drag.

This has always appeared evident to me, perhaps the easy experiment which proves the converse of it will prove the truth of this theory more plainly than argument.

Take two 6 pdrs. on carriages exactly alike. Reverse one gun, so as to bring the muzzle over the elevating screw, the right trunnion in the left trunnion hole. The reversed gun has the preponderance of the breech pressing down the upper end of the trail, that beyond the axle, the other gun as usual employs that preponderance to press down the lower end of the trail.

* Page 201.

Digitized by Google

The weights are equal, but the reversed gun will recoil three times the distance of the other. It will be three times as easy to limber up. For the same weight which it is difficult to lift to limber up, is all useful for checking recoil, but the dead weight is useful only to increase the number of horses necessary for each piece of Artillery.

Lieutenant Ash says* "that the present carriage is too light "is manifest from the circumstance that one began to crack at "an elevation," &c. &c. Now it cracked because it was weak, not because it was light. He proposes a new pattern of carriage, of which I should like to see a drawing, but which is to be 120 lbs. heavier than that in use.

We are at issue, I say the way to strengthen a gun carriage is to diminish its bulk, to substitute metal for wood, to avoid perforations. Lieutenant Ash proposes to increase the dead weight. I think we have more dead weight already than we can manage. Let us see,

	cwt.	qrs.	lbs.
A gun—6 Pounder.....	6	0	0
Saulwood carriage R. A. pattern....	12	1	21
„ limber „	13	0	17
40 rounds of ammunition.....	2	3	22
	34	2	4
Deduct 90 lbs. placed on the horses' neck.....	0	3	6
	33	2	26

Divide by 6—gives..... 5 2 14 for the weight each horse in a team of 6 drags.... 0 2 9 must be added for men on the limber, making... 6 0 23 total.

Griffiths says 6 horses can drag 5 cwt. each—we give them 6½ very nearly—and our pole horse carries (Griffiths page 157.)

	stone	lbs.
Weight carried by riding horse....	15	13
Add weight of pole.....	3	3
Total....	19	2

a horse is I think sufficiently loaded with nineteen stone up and dragging 6½ cwt.

* Page 201.

Digitized by Google

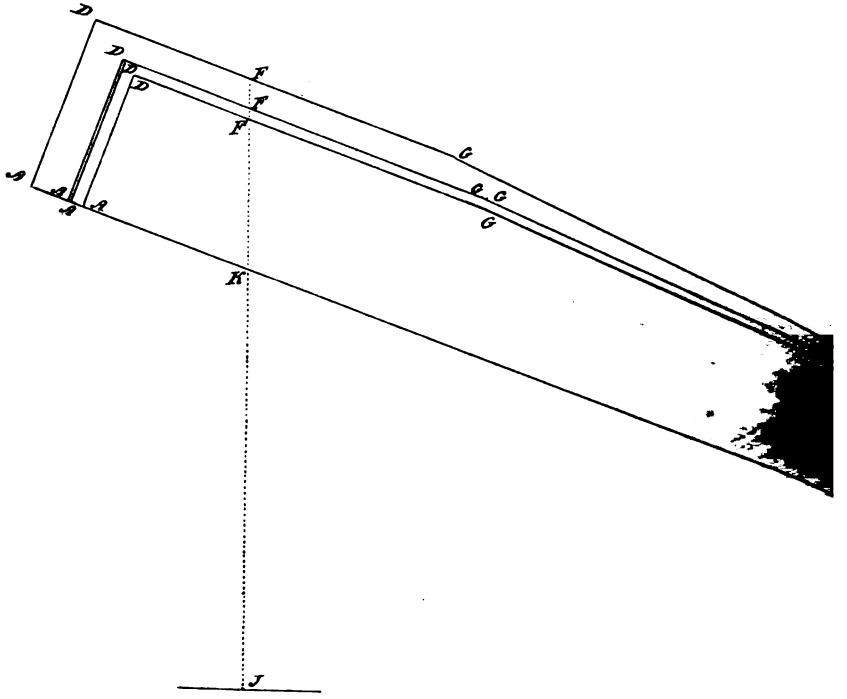
Digitized by Google

Miscellan

Refe

J.K.	= 33.1928 ins.	perpendicular.
J.I.	= 91.2 ..... „	horizontal.
I.K.	= 97.05 ..... „	∠ 20.°
I.u.	= 9.91 ..... „	horizontal.
u.V.	= 8.331 ..... „	perpendicular.
V.V.	= 13.8 ..... „	horizontal
I.a.	= a 8 = I b = $\frac{V S}{2}$ = 3.25 ins	
V.X.	= 5 ins.	
b.c.	= a.c = 18.72 ins.	
V.d.	= 6.66 ins.	
D.G.	= 30 .... „	

Common to all Field Carriages

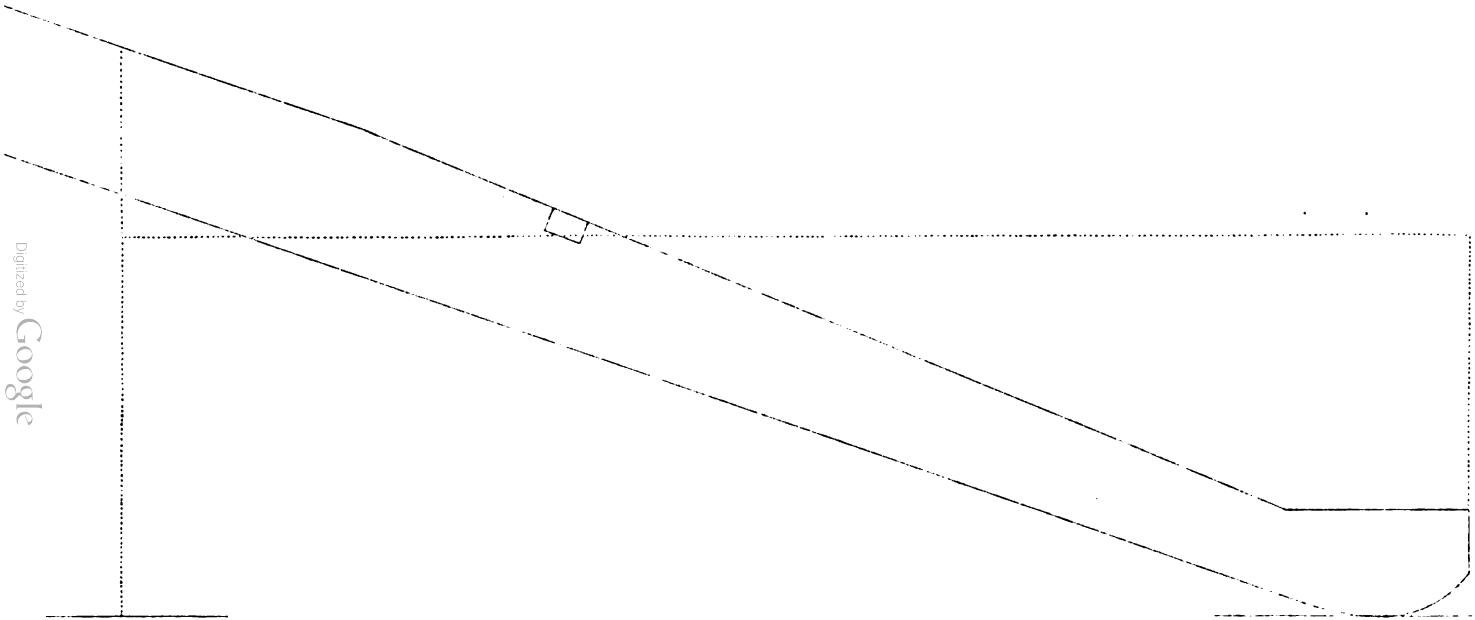


Art^y Depôt Lith.^a by W.F.

Digitized by Google

Digitized by Google

Digitized by Google



Digitized by Google

W.D. Depôt Lith.ª by W.P.

Digitized by Google

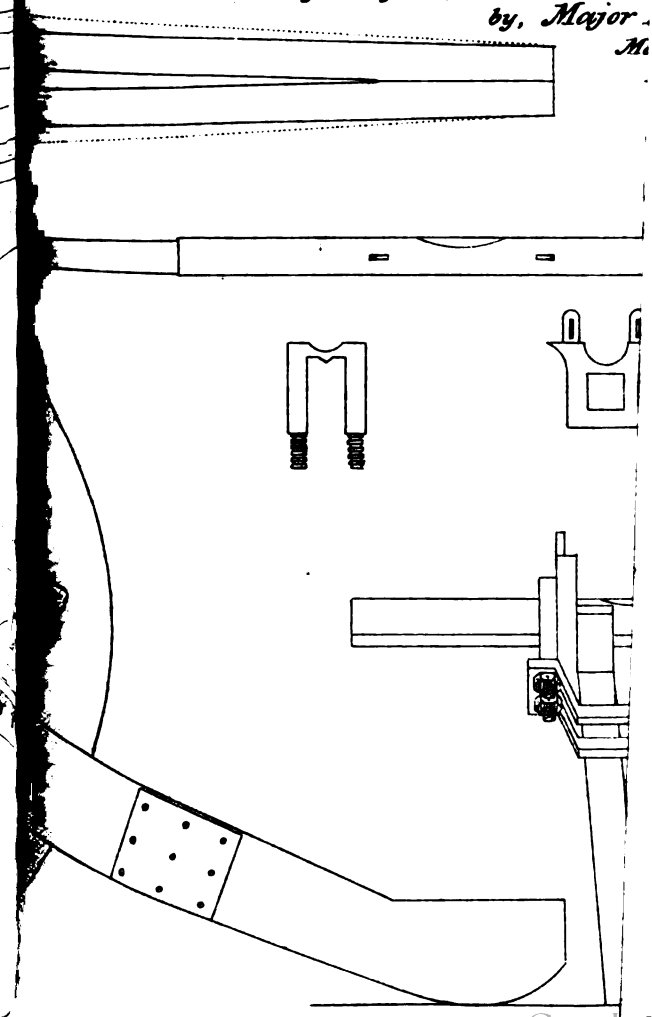


Digitized by Google

Digitized by Google

PLAN and ELEVATIONS,
of
N EXPERIMENTAL GUN CARRIAGE
built with
AXLE *between the* GUN *and* TRAIL
shewing
the Increase of Strength
and
Diminution of Weight,
with
Greatly facilitated Draught
resulting therefrom,

by, Major
M.



Digitized by Google

Digitized by Google

EXTRACT FROM A MEDICAL NARRATIVE OF THE DETACHMENT OF MADRAS ARTILLERY, WHICH WAS EMPLOYED IN THE LATE WAR IN CHINA IN 1840, 41 AND 1842; COMPILED FROM THE REPORT OF THE MEDICAL OFFICERS EMPLOYED.

Letter from Surgeon J. P. GRANT, *dated Chusan, 1st January* 1841.

"The troops here were much reduced during the first 6 weeks after our arrival by diarrhœa, which might be attributed to exposure to the sun and damp night air on duty, sleeping on the ground in tents or in bad quarters, want of good food, and the quality of the water being different from what they had been accustomed to."

"When the crops began to ripen in the middle of August, and the surrounding paddy fields became nearly dry, exhalations of noxious vapours generated a great number of cases of fever of the types already alluded to, and I regret to say lately several cases of dysentery; many of the patients who first suffered from diarrhœa were attacked with intermittent fever, the one disease alternating with the other. In some of these cases which have lately come under my observation, men, who had recovered from either and been on duty for some days, on being again attacked with dysentery, were in so low a state that active remedies could not be pursued."

"The range of the thermometer in this harbour during the month of August was,"

	Between decks.		In the poop cabin.	
	max.	min.	max.	min.
From 1st to 7th	88°	82°	87°	80°
„ 8 to 15	88°	80°	86°	79°
„ 16 to 23	86°	78°	84°	78°
„ 24 to 31	86°	80°	84°	76°

and in September up to this date,

	Between decks.		In the poop cabin.		
	max.	min.	max.	min	
From 1st to 7th	86°	80°	82°	75°	114 in the sun.
„ 8 to 15	88°	78°	86°	75°	
„ 16 to 25	82°	74°	80°	72°	

"Since the 16th instant, on which day Capt. Anstruther of the Artillery was captured by the Chinese, 4 parties of this Detachment have gone in search of him, several men of these parties had been previously ill with diarrhœa or fever, and from being in such a debilitated state had relapses, or have

Digitized by Google

been attacked with dysentery. In fact the men of this force generally are in so debilitated a state that I believe I may say there are few of them could go ten miles in heavy marching order without suffering from it afterwards."

"The sick of the Detachment of Madras Artillery have been well supplied with poultry until within the last 5 days. The *consommé* soup supplied among the medical comforts is poor and not palatable. I have generally added fowl or duck or *bouilli* soup to it, which, with the addition of two ounces of rolong for each man makes very good soup. It is exceedingly fortunate we brought so good a supply of the bouilli from Madras for the use of our Detachment."

"The European sick, Officers and Privates are sent on board the Ship "Rustomjee Cowasjee" under my charge."

"The Detachment of Artillery still encamped on the same ground we first took up. The other corps are encamped on the hills in the vicinity, up to this date only one death has occurred among the Europeans and Natives of this Detachment here, although the proportion of sick in both has been very great. The other corps here have not been so fortunate."—28*th September*, 1840.

"Both the Europeans and Natives of this force are daily becoming more emaciated and less able to withstand attacks of any disease; dysentery has made awful havoc among the Europeans of the force within the last 5 weeks. It is the same kind of dysentery which proved so fatal to the Europeans at Rangoon, the result of bad food and exposure to malaria and moist night air in tents or bad quarters. It may be denominated scorbutic dysentery."—19*th October*, 1840.

"The prevailing diseases during the half year have been fevers, of which there have been intermittent quot. 308 cases, do. tert. 53, do. ephemera 21, do. continued 2, diarrhœa 83, and acute dysentery 46."

Letter from Assistant Surgeon J. MIDDLEMAS, *dated Hong Kong Harbour*, 1*st July*, 1841.

"On the 17th of May, the Detachment was ordered to be in readiness for active service, and on the morning of the 19th left Hong Kong in the transports "Rustomjee Cowasjee" and "Eagle," having received orders to proceed forthwith up the Canton river. On the 23d we reached to within 6 miles of Canton and all embarked on board of large China chop boats on the 24th excepting the sick, and landed the same night above the city; next day, the 25th, a general action

Digitized by Google

took place, the forts on the heights of Canton were stormed and captured. Our men suffered severely during the whole of the day, the heat was intense, and they were greatly fatigued dragging the guns over extremely bad ground and heavy paddy fields, travelling over a space of nearly two miles, thei r thirst was excessive, which caused them to drink great quantities of water from the fields; while encamped on the heights we unfortunately had a great deal of rain, and there not being sufficient covering for the men, I regret that most of them were under the necessity of sleeping in wet clothes for two nights, they were also exposed for several days to the excessive heat of the sun. On the morning of the 1st the forts were vacated and the men reached their respective transports the same night, several suffering from bowel complaints and intermittent fever."

"Much sickness took place in the Detachment after its return from Canton, the prevailing diseases were intermittent fever, dysentery and diarrhœa, doubtless caused by the great fatigue and exposure the men had to undergo dragging the guns through paddy fields and over hillocks, studded with graves, making it a task of the greatest labour, several of the men having frequently been obliged to fall in the rear from mere exhaustion."

"During the period the Detachment was encamped on the heights (six days) in addition to the several days' exposure to the excessive heat of the sun, it encountered a very heavy thunder-storm, unfortunately, the covering for the men was slight and insufficient to protect them from the rain, consequently they suffered much from lying on damp ground and sleeping in wet clothes, which could not be avoided."

"The great increase of sickness in the Detachment during June cannot therefore be wondered at; I am happy to state that all in hospital are now recovering, although several of the cases were of a severe nature and required most active treatment."

"Nearly all the Officers of the Detachment, from the harassing duties they had to perform, together with the great exposure to the sun and rain during the time we remained in position on the heights of Canton, suffered more or less on our return from fever and bowel complaints, which happily yielded without difficulty to the usual remedies."

"The natives of the Detachment on our return were also affected in the same way but not to any extent. Casualties none."

Digitized by Google

Letter from Surgeon J. P. GRANT *dated Ningpo 1st Jan.* 1842.

" I have much satisfaction in stating that the Europeans of the Detachments of Madras Artillery serving in different parts of China have been more healthy during the last six months, than they were during the previous half year, and there have not been one-third of the number of serious cases admitted as at Chusan from the 20th of July to the 15th November, 1840. This may be attributed to two causes, viz. in the first place, that they were a greater portion of the time on board ship, during the autumnal months, when noxious exhalations, productive of fevers of various types and bowel complaints, are known to exist in all parts of China which we are acquainted with, and in the second, during that time they were not able to procure Shamshoo, which has been so great a source of disease, and productive of so much evil to the troops serving in this country."

" With regard to the casualties that have occurred in the various Detachments, I regret to state 3 out of 4 that took place here and at Chusan were from the men having drank large quantities of spirits."

" The health of the men now present is unusually good, when it is remembered that all of them with three exceptions were at Chusan last year, and suffered more or less severely both from climate and disease. The remarkable healthiness of the men may be ascribed to their being constantly on board ship during the last six months in a place where the range of the thermometer has been between 52° and 82°, and where the alteration of temperature is as sudden as it is great."

" They have had fresh meat daily, which is generally good and their usual allowance of spirits; there has been no case of the ill effects of intoxication or disease produced by it."

" I am happy to be able to state, that by the last accounts the Europeans of the Detachments at Chinghae, Chusan, Amoy, and Hongkong, continued in good health."

" Among the native troops attached to the Artillery, only two casualties have occurred, both in old worn out men; considering the severe weather they have been exposed to, when the thermometer has been frequently below 20°, it is a matter of surprise how few deaths have occurred among them since we came to China, it can only be attributed to the great care that is taken of them by those who have command of them."

" The prevailing diseases both among the Europeans and Natives have been intermittent fevers, diarrhœa and dysentery."

Digitized by Google

Letter from Surgeon J. P. GRANT, *dated Singapore Harbour, 1st January,* 1843.

The men have suffered more in June than during either of the five preceding months, there having been forty-six admissions, not including natives, chiefly affected with diarrhœa; however nearly all those occurring between the 23d and end of the month may be entirely attributed to the men partaking largely of unripe fruit, during the march from "Shanghai" to "Woosung." Although this Detachment has suffered but little from sickness during the cold weather, I fear during the approaching hot season, a good deal of sickness, principally fever, which, with very few exceptions all the men who have been out in China for any length of time are very subject to, may be expected."

"In addition to this, our operations will now in all probability be confined to this river, its banks, with the neighbouring country, in most of the places we have yet visited, being low, flat and marshy, and places where disease might be expected to emanate." *Off Woosung Yangtzekiang River, 1st July.*

"With regard to the health of the Europeans of the Madras Artillery, they have suffered much from fatigue and exposure to climate, particularly that portion of it in the Yantzekiang river, and considering the circumstances under which they were placed, with the head quarters of the Yantzekiang, a Detachment at Chusan, a Detachment at Kolungsoo and some sick at Hongkong, with the exception of the Kolungsoo Detachment, the mortality has not been so great as might have been expected, the sufferings of the men of that Detachment must have been very great." I send herewith, part of the report of Lieutenant Elliot of the Artillery, regarding his Detachment.

Letter from Lieutenant G. S. ELLIOTT, *2d Battalion Artillery, dated Kolungsoo, 15th October,* 1842.

"I have the honor to forward for the information of the Officer Commanding the Madras Artillery serving in China, a present state of the Detachment of that Corps under my command upon this Island, and it is with extreme regret that I have to make a most melancholy report; disease and death have made sad havoc with this unfortunate Detachment; of the seven men reported present for duty, most appear fit inmates for an Hospital. One hard day's work would lay the

Digitized by Google

greater part of them up, so debilitated and pulled down are they by severe attacks of sickness."

"But perhaps it would not be totally uninteresting to the Officer Commanding were I to give a short detail of the progress of the disease which has carried off so many of our men; it first appeared amongst us towards the latter end of June in the shape of a violent remittent fever; during the month of July twelve or fourteen men of the Royal Irish were carried off by it; the most violent remedies were required to check even for a time the severity of the fever, but in many cases these completely failed, and the patients expired delirious within from 24 to 60 hours after having been attacked; calomel and mercury in other forms were used in vast quantities, and where salivation was effected the patient did well, but where it was found impracticable, in almost every such instance they expired."

"My Detachment continued free from disease until the latter end of July, when Corporal Scott was attacked and died after a very short illness. My serjeant was taken ill on the morning of the 5th of August, and died on the 7th. Several others were attacked about the same time. This month proved to be the most unhealthy."

"The Medical men had hitherto considered that much of the sickness was occasioned by that vile Chinese liquor Shamshoo, and to great exposure to the sun, but when they saw steady Non-commissioned Officers, who neither indulged in the former, nor unnecessarily exposed themselves to the effects of the latter, carried off by the fever in all its worst forms, it became necessary to seek for some fresh cause. Every thing was done which the Commandant and Medical men could think of to check the ravages of the disease. The sentries for the most part were taken off during the heat of the day; every barrack-room was freely ventilated, but all to no avail; towards the latter end of August it appeared amongst the Officers, from six to seven of them being attacked within a few days of each other, I was seized with the fever on the 22d. The Medical Officer sent me the same evening on board the "*Thomas Grenville*" transport, from 30 to 40 convalescents and weakly men had been embarked in her for the benefit of the sea air, and upon the following day she was ordered to sea to cruize for ten days outside the harbour. Fortunately I escaped the worst form of the disease, and when we returned, I was considerably better, but just then I got a relapse which again laid me up; however upon the 29th

Digitized by Google

September I was discharged from the sick list and returned to the Island perfectly recovered."

During the month of August, the Royal Irish lost three Officers and fourteen or fifteen men ; the barracks were then totally abandoned, and the men placed under canvass on the ridge of a hill overlooking the sea where they had the full benefit of whatever breezes blew. At first this had no decided advantage, but towards the middle of September the cases for the most part ran into fever and ague, when the disease was checked considerably ; many casualties however still occurred, and those who recovered were so weakened in constitution that it required weeks to bring them round."

" Only two Europeans have escaped the sickness, and those are the Assistant Surgeon of the Royal* Irish Regiment, and the Serjeant Major of that Regiment. The deaths amongst them amounted to between fifty and sixty, in the three months of July, August and September, one-sixth of their original number. The natives for the most part escaped the fever, but have suffered considerably from ague, the shipping too escaped which clearly proves that in the summer months this Island is unhealthy."

" The weather is now cool and pleasant, but there is a great deal of fever and ague, and at the present time two-thirds of the Europeans are in hospital."

" Many men of my Detachment have been so broken down in constitution that I fear they will never be fit for any duty excepting invalid. Bombardier Foley had perfectly recovered from fever, but upon going to his duty a few days since he was attacked with severe pains in his head and body, and so debilitated was he in constitution that he sank under the necessary remedies."

" I trust however that the ensuing cold season will restore some of them to strength. The tents are now found too cold for the Europeans, and by the advice of the Medical Officers they were all removed yesterday morning into their former barracks, which had been previously white washed and purified."

Letter from Surgeon J. P. GRANT, *dated Singapore Harbour, 1st January*, 1843.

" I may here remark that during the last thirty-three months the Madras Artillery has been on this service, the casualties among the Europeans including men killed in action, drowned, kidnapped, died of apoplexy from drinking Shamshoo, or exposure to the sun, and other diseases amount

* Since dead.—J. P. G.

Digitized by Google

to 9 per cent. per annum, those among the first batch of Gun Lascars amount to 1¼ per cent."

"From our experience during the last three years, we have found that the swamps along the banks of the Canton and Yangtzekiang rivers, and the marshes and paddy fields of Chusan, are not more productive of Malaria than the Island of Kolungsoo, which is chiefly composed of granite and light sandy soil, and where there are apparently no sources of Malaria, or at Hongkong which is composed of granite, a large portion of it in a disintegrated state, and iron hornblende, which appears after rain when exposed to the rays of a powerful sun to be the source of most deleterious Malaria."

"The number of sick, wounded and worn out men who were sent to Chusan, together with sickly Recruits who arrived from England, was above 600 Europeans, yet the casualties were proportionably few, which may be attributed to the men in hospital being well attended to, and being well supplied with comforts of all kinds and good diet, excepting mutton and milk, which are not to be procured there to any extent, and the men in barracks were well looked after, prevented from drinking Shamshoo as much as possible, kept out of the sun during the day, and well fed with fresh beef and good bread. The buildings in which they lived were also the best we have had since we have been in China."

"Remarks on the health of the Natives. Since the commencement of this expedition, the number of casualties has been very small in the gun lascars, sappers and miners and the rifle company, 36th Regiment M. N. I., compared to that either in the two Bengal volunteer corps, and the six Madras Native Infantry Corps; this may be attributed to the former having fed themselves better."

"The Detachment of Madras Sappers and Miners, although hard worked during the summer and autumnal months, and the Detachment of gun lascars stationed at Chusan enjoyed good health with few exceptions."

"In concluding my remarks on the health of the Native Troops employed on this service, I have only to reiterate the same opinions which I have given the Medical Board since 1825; viz., that none should be sent on board ship for foreign service, but able bodied men; they should be inspected in undress parade weekly by the medical officer in charge, otherwise they will get the itch from living so much on salt fish, and as their habits are filthy they prefer being dirty to bathing in sea water. Officers commanding corps should not

Digitized by Google

allow them to leave such large family certificates, which prevents their being able to feed themselves sufficiently well to perform the duty of efficient soldiers, and when they get attacks of disease they in too many instances sink from want of stamina. *The pension list is thus much increased!*'

"From our exprience it appears that the lower the caste of the corps the more efficient it will be found to be in such a service as that which we have been employed on inChina; this will be evident on comparing the health of the gun lascars, sappers and miners and Officers' servants, who eat all sorts of animal food, with the corps chiefly composed of men of caste who are precluded from doing so from religious prejudice; and finally, no expense should be spared in having the sepoys warmly clad, well housed, and made to sleep on beds well raised from the ground, particularly corps sent to China, where the vicissitudes of climate are so great and the cold in the winter months (viz.) November, December, January, February, and March is so severe."

"Prevailing diseases,—during the year in the detachment of Artillery, have been diarrhœa, deaths 2, acute dysentery, deaths 2, acute hepatitis, death 1, apoplexy, death 1, anasarca, death 1, epilepsy, death 1, gun shot wound, death 1, atrophia, death 1, and scorbutus, death 1. Total deaths 11."

"Diarrhœa.—During the summer and autumnal months we have found this disease to be of very frequent occurrence, most difficult to be cured, and in too many instance fatal in its termination, although this year our troops have been placed under more favourable circumstances than they were in 1840, still this disease, combined with intermittent fever, has existed to some extent; and I fear the autumnal months will be still more unhealthy than those of summer."

"In consequence of the peculiar position of the troops on such a service, *post mortem* examinations have not often been made except where a ship was allotted as an hospital ship."

"I have however made a great many examinations of men of other corps who died in China of the prevalent diseases, diarrhœa, and dysentery, and the appearances have been similar throughout, to those noted in my first report to the medical board."

"The diet of the men of the detachment of Artillery has been as good as could be expected; when they had not fresh beef, they got good salt beef and vegetables, and they were supplied with the usual quantity of good spirits."

Digitized by Google

amount of Sickness and Mortality amongst the Detachment of Madras Artillery serving in China, during the 41 *and* 1842.

	Diseases.																								
	Apoplexy.	Beriberi.	Cholera.	Colic.	Diarrhœa.	Dropsy.	Dysentery.	Fevers Ephem.	Fevers C. C.	„ Inter.	„ Remit.	Hepatitis.	Inflammation external.	Abdominal.	Cephalic.	Thoracic	Mania.	Pulmonary disease.	Rheumatism.	Scrophula.	Small Pox.	Venereal diseases.	Ulcers.	Wounds and accidents.	Diseases of the Eye.	Do. do. Skin.	Other complaints.	Total.
tted..	1	0	2	1	88	2	58	22	7	363	0	6	8	1	0	0	0	0	7	0	0	8	11	8	0	0	22	616
.....	1	0	0	0	3	0	7	0	0	3	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	16
tted..	1	0	1	1	90	2	35	6	0	152	2	5	5	1	0	4	0	1	8	0	0	17	8	50	2	1	58	450
.....	1	0	0	0	2	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8
tted..	1	0	3	2	170	2	33	38	8	593	7	14	16	8	3	5	1	0	28	0	0	25	15	74	2	4	117	1169
.....	1	0	0	0	3	1	2	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	3	0	0	3	16
itted..	3	0	6	4	348	6	126	66	15	1108	9	25	29	10	3	9	1	1	43	0	0	50	34	132	4	5	198	2235
.....	3	0	0	0	8	1	10	0	0	5	2	1	0	0	1	0	0	0	2	0	0	0	0	3	0	0	4	*40

number, between 35 and 40 of those sent to Manilla and Madras for change of air died. *Editors, Madras Quarterly Journal.*

Digitized by Google

IMPROVED CHAIN SHOT.

Letter from Lieutenant and Brevet Captain H. CONGREVE, *Madras Artillery, to the Secretary of the Honorable East India Company, in the Military Department, London.*

I have the honor to put at the disposal of the Honorable the East India Company, an improved chain shot, which has just occurred to my mind. In order not to trespass on your time, I will endeavour to explain, as concisely as possible, the nature and amount of this improvement.

There is a common shell separated into hemispheres, the concave surfaces of which are subsequently connected by a chain of such dimensions, as to be admissible into the hollow ball, when its disunited portions are screwed together. This much, however, I apprehend, is nothing new, for I have an impression to the effect, that I saw some years back a similar contrivance, rejected though, I suspect, in consequence of being subject to the objection which may be opposed to every description of chain shot hitherto suggested, amounting to this, that no reliance can be reposed in the shot's adhering to the proper track, owing to the air, when the range is in excess of a few 50 yards, retarding the progress of the shot in its expanded state and influencing it to deviate from its course. To obviate this objection, I recommend that the junction of the hemispheres of the shell shall be the circle or ring of least resistance to a bursting charge on being exploded through the means of a fuze of a regulated length, when within a few yards of the object against which the shell is launched, for instance, in case it were necessary to ruin the masts and rigging of a vessel at 800 yards distance, the fuze of the new chain shell must be cut to such a length as will occasion the shell's bursting at a distance of 700 or 750 yards from the mouth of the piece out of which it is discharged, the inconsiderable space the projectile has subsequently to travel, will scarcely suffer the opposing current of air to deflect it from its path.

I do not hesitate to express my thoughts, that the funnel of a steam ship might be severed by a chain shot of this description, and I base this conjecture on the circumstance of my having cut a musket barrel clean in half, simply with a charge of shot fired from a fowling piece at a few yards distance. A chain shot flying over a ship, if the chain were parellel with the deck and within a few inches of the planks, would propagate frightful destruction amidst the crew in the course of an action ; that is, if the fuze were so cut as to give rise to the shell's expanding at the precise moment. Discharged at the rigging, the chain shell would overthrow all before it, masts, shrouds, stays, and so forth. When employed against troops

Digitized by Google

the havoc the shot would occasion amongst masses, would be prodigious.

The shell, in course of preparation, is loaded with the bursting charge subsequently to the hemispheres being screwed together, the powder being shaken down amidst the links of the enclosed chain.

P. S. I have observed in the foregoing letter, that the effect of this new chain shell would be tremendous "if the chain were parallel to the deck" during the shell's flight across it—this important object I can readily achieve.

Let the hemispheres of the shell be sub-divided into quadrants, and two distinct chains introduced, in order that each quadrant may be connected with the one immediately facing it, the two chains to cross in the centres of their lengths, moreover, to be joined at that point, the quadrants to screw together, and the circles of conjunction to be of the least resistance. Vide, Plate 68 Fig. 1 and Fig 2.

NEW MARTELLO TOWER, BY LIEUTENANT AND BREVET CAPTAIN H. CONGREVE, MADRAS ARTILLERY, 1843.

The following simple plan for a tower, is strongly recommended to notice, inasmuch as while the edifice partakes of all the advantages of the martello tower now used on the coasts in Europe, it may be constructed at a very small cost; and what is a point of equal excellence, it is scarcely susceptible of injury from the fire of ordnance directed upon it. The dimensions of the suggested work must considerably surpass those of the old stone tower, and in substitution of the cylindrical mass of masonry of the latter, a skeleton building of three rough stone pillars, Plate 69, Fig. 3, is to be erected, and surmounted with a platform of any material, capable, owing to its size, of admitting of the presence of as many guns, under five or six, as circumstances may require. A thin parapet of planks is to be run up from the level of the platform, to a height adequate to the concealment of the guns, and to afford, when roofed over, shelter for the small garrison and their ammunition against the weather. The shape of each of the three pillars, moreover, should be that of the sector of a circle, the centre pointing outwards, in order to obviate any ill effects that might arise from a shot alighting upon one of the supports of the structure, for the projectile would be deflected on coming in contact with the salient angle, and pass clear of the masonry. The outline of the work thus being obtained, the next thing to be accomplished, is to fill up the spaces subsisting between the pillars, with cohesive earth or clay well beaten down and thus indurated. This being

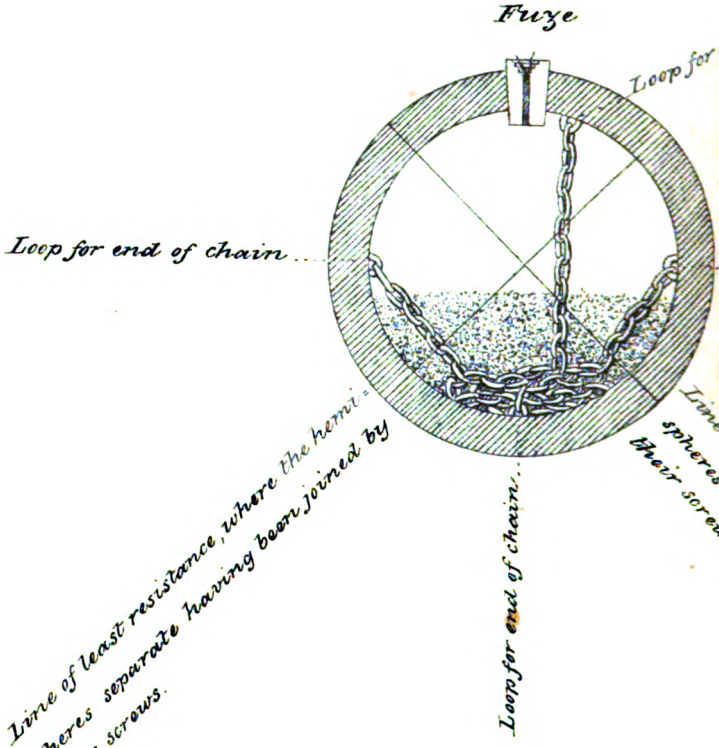
Digitized by Google

Digitized by Google

by Lieut & Br

Fig. 1.

Section through Chain Shell scre



Artillery Depot Lith.ª by W. P.

Digitized by Google

Plate 68

n Shell,

aptain H. Congreve.

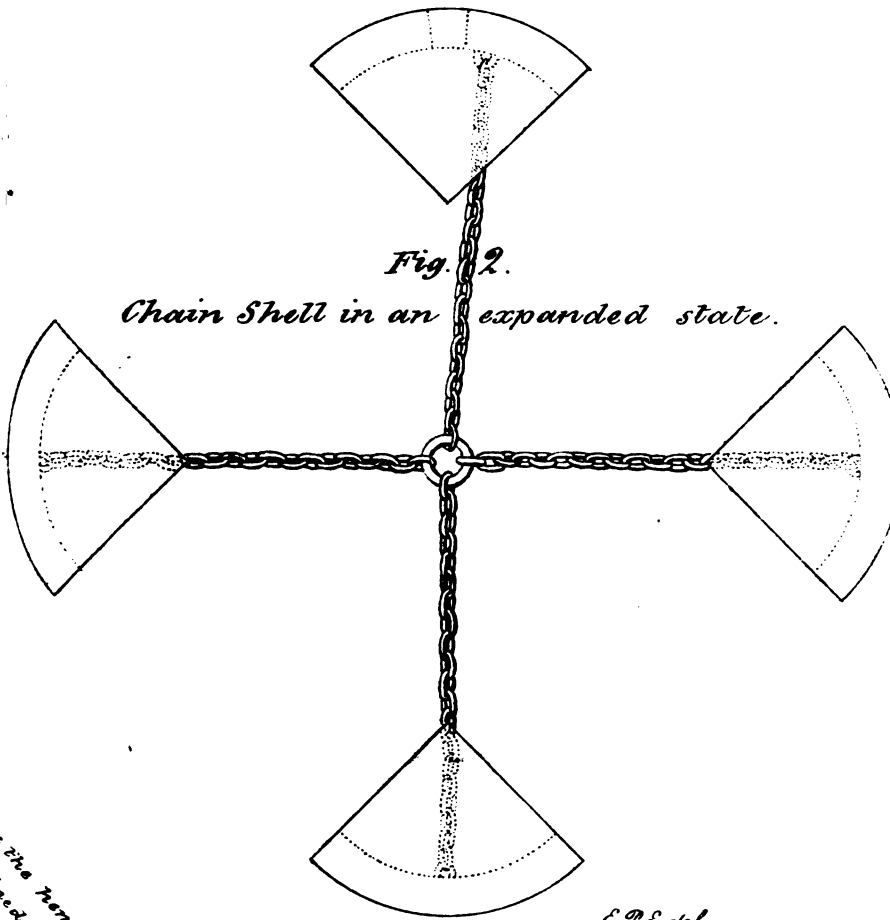


Fig. 2.

Chain Shell in an expanded state.

C. P. E. del.

e the permis-
ned by

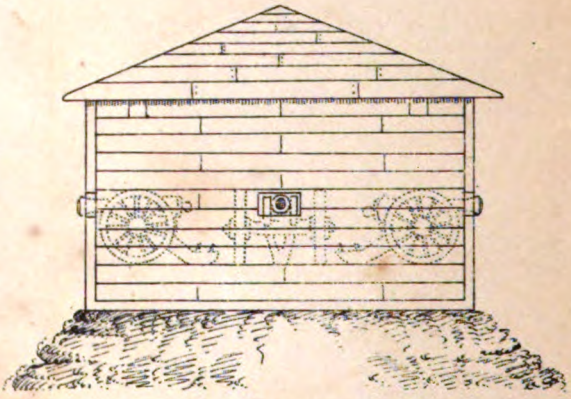
Digitized by Google

Digitized by Google

Digitized by Google

New Ma
by Lieut & Brev

fig. 2.



Elevation of Block House on summit of mound, containing 4 Guns of large calibre.



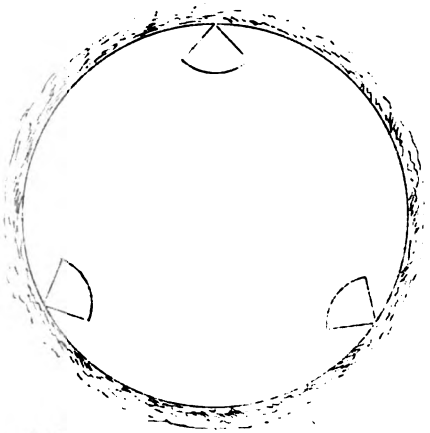
Appearance

Art. Depôt Lith. by W. P

Digitized by Google

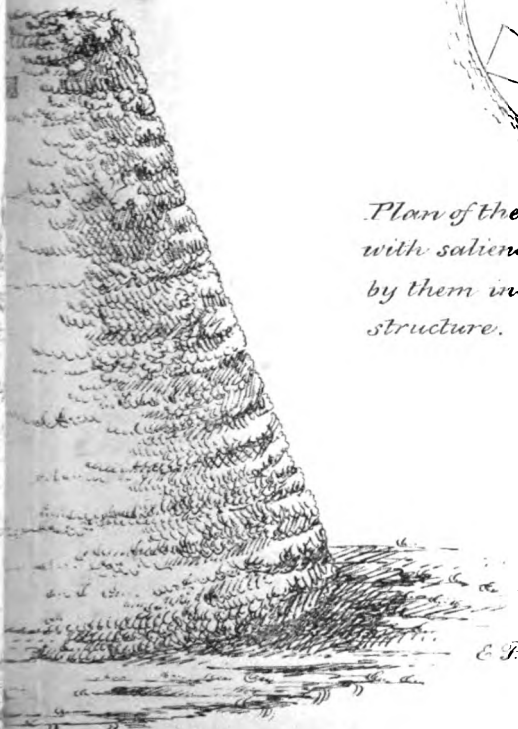
llo Tower,
ptain H. Congreve.

fig. 3.



Plan of the stone frame work of the mound,
with salient angles to defend the shot if struck
by them into the solid earthern body of the
structure.

1.



E.P.E. del.

completed and masked
h turf.

Digitized by Google

Digitized by Google

finished, an envelope of earth work, several feet in depth Plate 69 Fig. 1, must next be made to encircle the whole structure, including the plank parapet above, leaving the embrasures of course unblinded.

The block house or battery on the top of the tower, Plate 69, Fig. 1, should be rendered accessible, through the means of a ladder, made to draw or fold up in the event of an assault.

Some of the advantages of this castle, in preference to the old martello tower, may be briefly enumerated as follows;

1. Simplicity of plan.
2. Economy in construction.
3. The great elevation it may be run up to, and the extensive command of sight and fire thereby acquired.
4. Its being out of danger from the fire of Artillery.
5. Its uncommon size enable the largest pieces of Ordnance being mounted upon it.
6. The very efficacious protection afforded by it, to a road, stead or landing place.

A PROPOSAL FOR BESTOWING AN ACQUISITION TO THE STRENGTH OF THE ARMY OF INDIA EQUAL TO NINE REGIMENTS OF INFANTRY, ATTAINABLE AT NO COST TO THE STATE, AND WITHOUT RECOURSE BEING HAD TO A LEVY OF RECRUITS, BY LIEUT. AND BREVET CAPT. H. CONGREVE, MADRAS ARTILLERY 1842.

The circumstances that have occurred in India within the last year, whereof the expedition beyond the Indus and the demise of Runjeet Sing may be considered the most conspicuous, must inevitably give rise in the sequel to the occupation of a much greater range of territory than that now held by the troops belonging to the East India Company, already considerably dispersed; and to a consequent deficiency in the strength of the Military resources upon which the stability of the Government depends. The precaution that first suggests itself to arrest the evil consequences which might ensue, comprehends of course an immediate augmentation of the Forces, commensurate to the discrepance that will prevail. When fresh men are entertained, they will while their veteran brethren in arms are on active service, be employed to maintain order amidst the provinces under the Company's sceptre, and to keep on the alert on purpose to counteract whatever efforts at revolt may be made by those disaffected characters common throughout India, who so readily manifest symptoms of infidelity when opportunities offer, in the vain hope of improving their own impoverished circumstances in menacing

Digitized by Google

the authority of the reigning power. Individuals of this description, it is notorious, are constantly in the habit of practising upon the loyalty of the recruits of the Army, in order to gain them over to their own pernicious purposes, and they not unfrequently find in them ready accessaries in consequence of the fair promises they hold out, and because the young soldiers in many cases are anxious to emancipate themselves from the restraint, odious when collated with their former unshackled condition, a Military life imposes upon them. It will readily be acknowledged, that the unsteadiness of feeling which fresh men so often entertain towards their employers, is a paramount objection to the enlistment of recruits in troublesome times, particularly as it has been shown they are necessarily thrown in contact with the disaffected portion of the population: and the same may be taken as a powerful argument in behalf of the introduction of any system that would effect the rising of a body of armed men, able at once to participate in the most arduous duties of the field, thereby empowering tried and trusty soldiers of the Army to garrison the interior stations that otherwise would be committed to the precarious guardianship of raw and wavering recruits.

Such a plan is devised, and may be carried into operation with every facility, and without a farthing's outlay.

It comprises in a word the arming without exception, of every Artillery driver, gun lascar, tent lascar, and store lascar, borne at present on the muster roll of the Company's Forces.

The subjoined table exhibits the distribution of these men with their numerical strength at the separate Presidencies. It must be observed that the figures corresponding to the seat of Government are only assumed as accurate in consequence of the pusity of information I had access to. The numbers, howreve, cannot be very wide of the mark.

	Arty. Drivers	GunLascars	TentLascars	StoreLascar
Bengal..... ..	1000	1000	2000	800
Madras.....	620	520	1350	400
Bombay..,.....	„	500	400	400
Total in each rank	1620	2020	3750	1600

Grand Total in round Numbers, 9000 Men.

DETAIL OF THE PLAN.

THE ARMED ARTILLERY DRIVERS.

Each man ought to be equipped with a light Carbine that may be slung across his back, and long narrow stiletto bayonet to fit in a scabbard suspended from his left side—weapons that would not prove cumbersome to the wearer, nor prohibit

Digitized by Google

him from efficiently performing his duty of guiding the Ordnance draft cattle. The strength of a company of Artillery having its drivers armed as proposed, would be enhanced by upwards of fifty bayonets in excess of what it has at present, and the company under such circumstances might be considered nearly independent of any extraneous aid, such, for instance, as that the Infantry afford; for squares in the event of Cavalry charging, could be formed out of the guns and limbers, having the intervals subsisting between them occupied by the Artillery *personnel*, numerically increased as now suggested, and by the presence of armed lascars as well, of whom more presently.

When Ordnance is removed from one park to another in the field, or in disturbed districts, and of the Artillery *personnel* accompanied by the drivers only, as often happens, it is found indispensably necessary to allot a detail of infantry to sustain the escort duties, a course of proceeding that entails upon the line the liability of having its numbers diminished on occasions when it most requires its full complement; this great evil would be obviated by the expedient of arming the drivers and thereby conferring upon them the ability of personally defending their guns.

The Artillery Drivers when armed, could moreover perform all garrison duties at the head quarters of their Regiment, instead of the infantry, not unfrequently so employed under prevailing circumstances.

II.

ARMED GUN LASCARS OF ARTILLERY.

What has been said respecting the armed drivers is equally applicable to the gun lascars, who, when armed, would contribute to the efficiency and independence of the Artillery in the field, by conferring upon that branch an accession to its number of fighting men.

Armed Lascars when employed in pioneering a way for their guns, would not need to be under any apprehensions if they encountered a party of the foe, with whom they would possess equal prospects of success if a conflict took place.

It would conspire much to the excellence of the Artillery, if the drivers and gun lascars were initiated in the exercise of field pieces, in order that when in action, should a gunner be slain or rendered *hors-de-combat*, one of those men could take his place, or if the entire party of Artillerymen could no longer perform their duties, all the drivers after picketting their bullocks, or the lascars having laid aside their arms and implements, might step in, man, and work the gun.

Digitized by Google

III.

ARMED TENT AND STORE LASCARS.

When made soldiers of, will prove of unspeakable service. It has been mentioned that at present the number of fighting men belonging to the Indian Army is considerably diminished, owing to the infantry furnishing escorts to convoy stores, ammunition, &c., and what aggravates the case is the circumstance that the tent and store lascars in numbers generally exceeding the strength of the guard, saunter lazily on with the carts, absolutely with no present occupation, and only that in prospect of unpacking the stores on arriving at their destination, and of assisting to pitch a few tents; whereas, if armed, they might guard the stores without any aid whatever.

Store and Tent Lascars on being armed, would be prepared to resist an offensive movement upon the Arsenals, Magazines, Depôts, &c., to which they stood attached.

They should be similarly furnished as the drivers and Artillery Lascars, with carbines and bayonets.

THE GENERAL ADVANTAGES OF THE PLAN.

1. 9,000 men at arms, are added to the Forces in India.

2. No further expense need be incurred by the State, in the attainment of that important object, than what is commensurate with the wear and tear of the arms.

3. Indeed there is a palpable saving for the men, would be satisfied with their present pay, which is somewhat under that of the Sephai.

4. The bounty granted to 9,000 recruits is saved.

5. The men proposed as the Agents of the plan may be regarded as old soldiers.

6. They are faithful and invariably manifest great attachment to the service; this observation I can confirm by personal experience. I held an appointment in the Ordnance Commissariat in the field, than which there is no place better calculated to elicit a true display of men's feelings towards their employers.

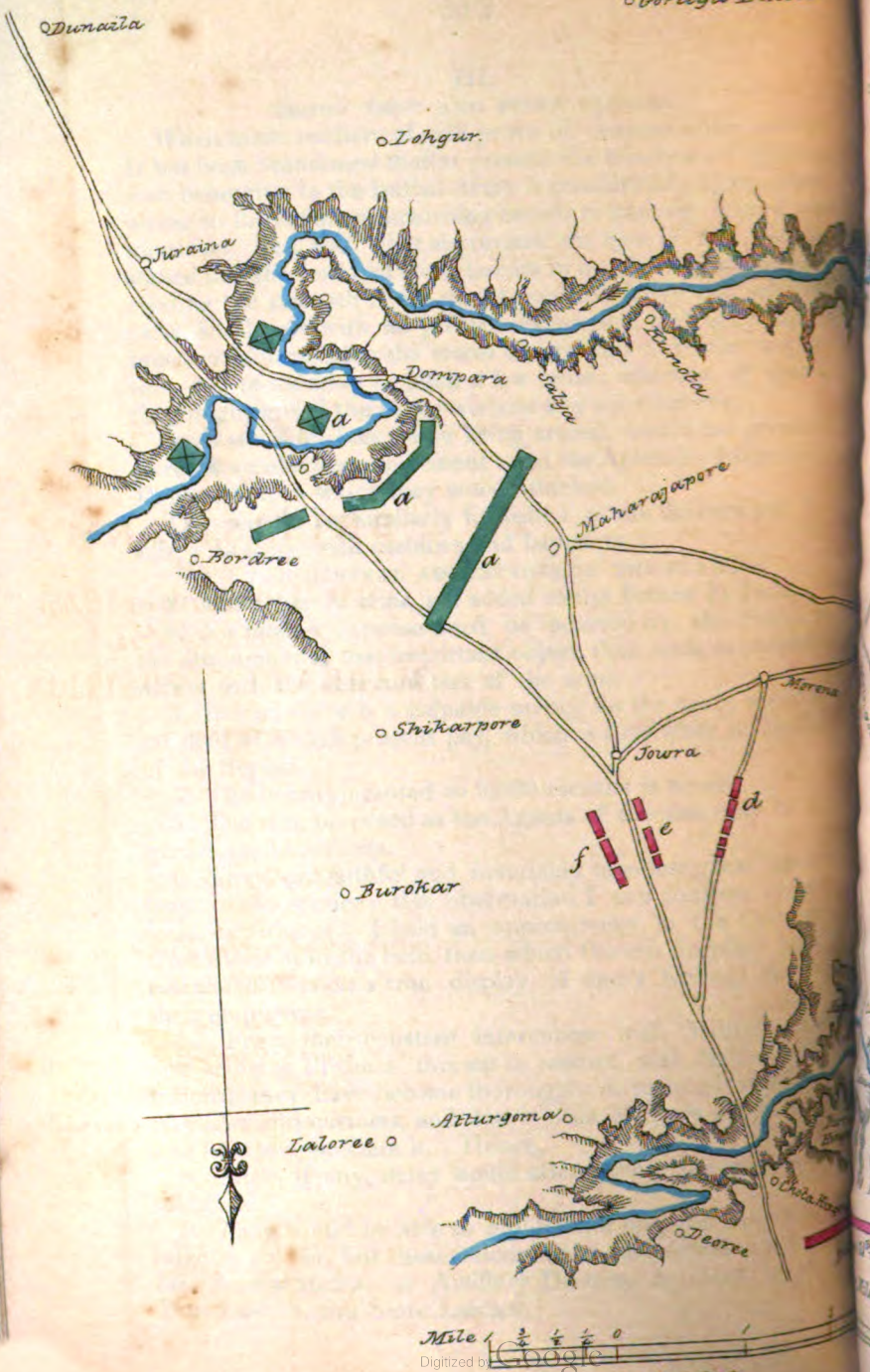
7. From their constant intercourse with Military men, and being at all times thrown in contact with Military institutions, they have become thoroughly acquainted with Military laws and customs, and know what Military discipline is, and how to appreciate it. Hence,

8. Little, if any, delay would attend their inauguration as soldiers.

9. They would be able to achieve not only the duties of an infantry soldier, but those belonging to themselves as well, in their several stations as Artillery Drivers, Artillery Lascars, Tent Lascars, and Store Lascars.

Digitized by Google

Digitized by Google



Digitized by Google

ous

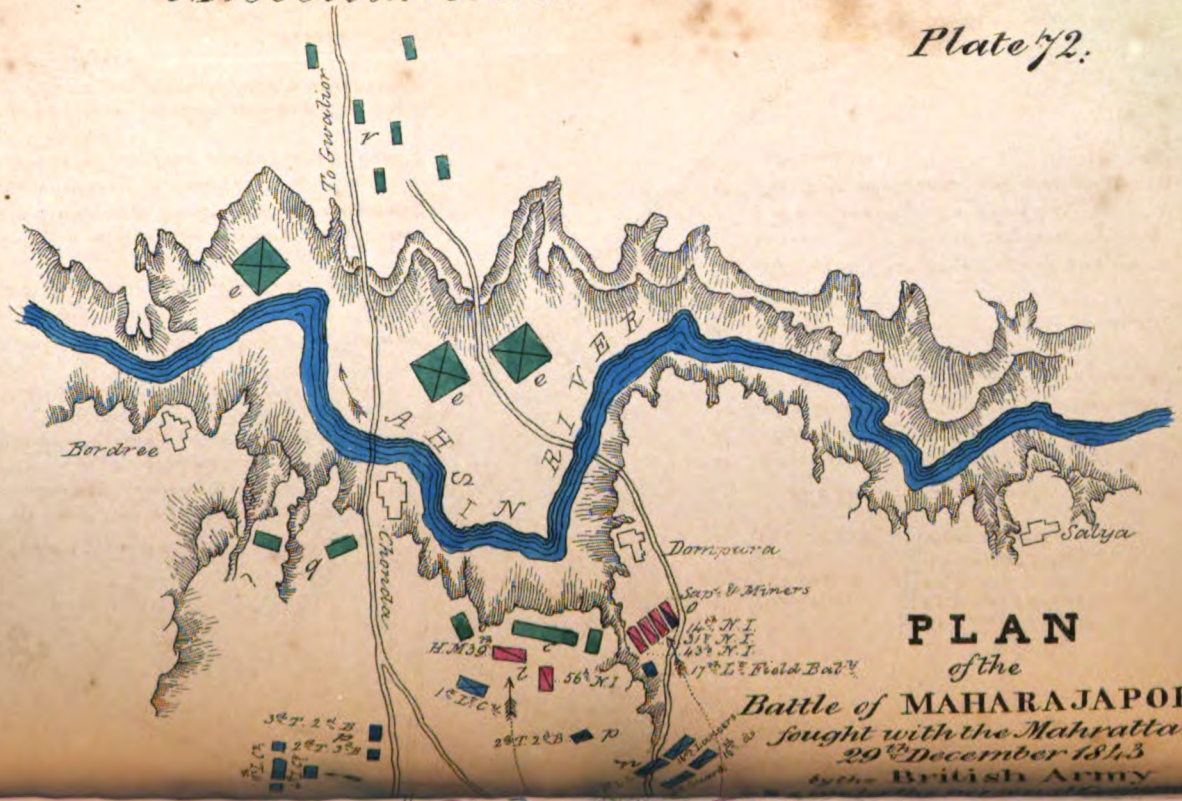
P



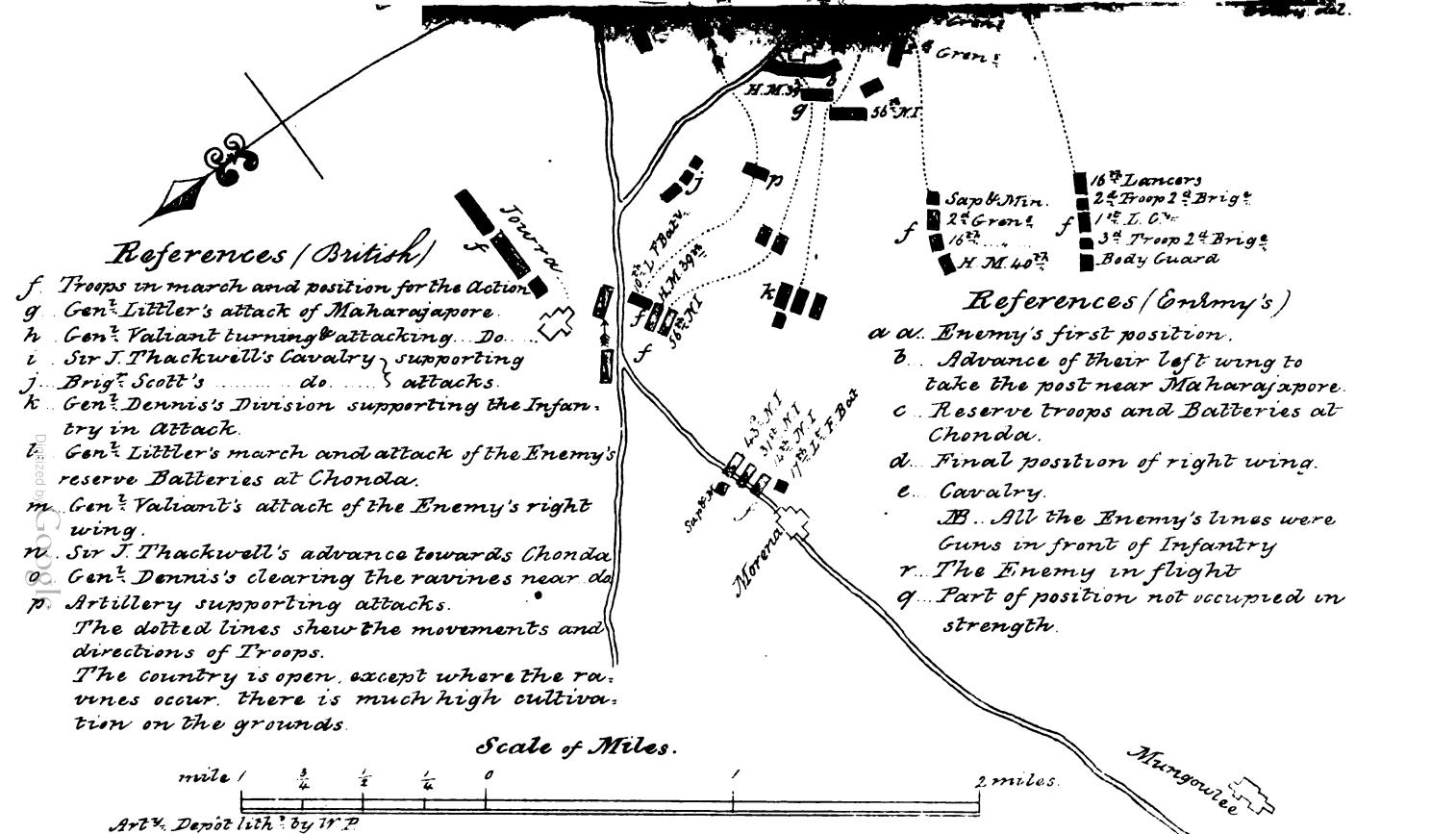
Digitized by Google

Digitized by Google

Plate 72.



Digitized by Google


H.M.39th
56th N.I
Gren.s
Sap.rs & Min.rs
2d Gren.s
16th ....
H.M. 40th
16th Lancers
2d Troop 2d Brig.e
1st L.C.
3d Troop 2d Brig.e
Body Guard
Jowra
16th L. Boat
H.M. 39th
56th N.I
43rd N.I
33rd N.I
1st L.F. Bat.n
Sappers
Morena
Mungoulee
References / British /
f. Troops in march and position for the Action
g. Gen.l Littler's attack of Maharajapore.
h. Gen.l Valiant turning & attacking ... Do. ...
i. Sir J. Thackwell's Cavalry } supporting
j. Brig.r Scott's ..... do. ..... } attacks.
k. Gen.l Dennis's Division supporting the Infantry in attack.
l. Gen.l Littler's march and attack of the Enemy's reserve Batteries at Chonda.
m. Gen.l Valiant's attack of the Enemy's right wing.
n. Sir J. Thackwell's advance towards Chonda
o. Gen.l Dennis's clearing the ravines near do
p. Artillery supporting attacks.
The dotted lines shew the movements and directions of Troops.
The country is open, except where the ravines occur. there is much high cultivation on the grounds.
References / Enemy's /
a a. Enemy's first position.
b. Advance of their left wing to take the post near Maharajapore.
c. Reserve troops and Batteries at Chonda.
d. Final position of right wing.
e. Cavalry.
BB. All the Enemy's lines were Guns in front of Infantry
r. The Enemy in flight
q. Part of position not occupied in strength.
Scale of Miles.
mile / 3/4 1/2 1/4 0 1 2 miles.
Art.y Depot lith.d by W.P

Digitized by Google

NATIVE INFANTRY LINES, RENDERED CAPABLE OF DEFENCE.

Letter from W. EDWARDS, Esq. *under Secretary to the Government of India, Foreign Department, dated Governor General's Head Quarters, 24th February* 1844, *to the Secretary to the Government Fort Saint George.*

With reference to Mr. Secretary Currie's letter No. 81, dated 23d December last, forwarding Copy of a despatch from the Resident at Hyderabad, the Governor is disposed to think that the Government of Fort St. George may now have under its consideration the expediency of building new Bells of Arms adjoining the Lines of the Regiment, or of moving the Lines towards the Bells of Arms. In either case it may be convenient to the Government of Fort Saint George, to be in possession of the accompanying copies of Plans and Report recently furnished to the Governor General, drawn up by the Chief Engineer with the Army of Gwalior on the subject of rendering all Native Infantry Lines capable of defence—These I am accordingly directed by His Lordship to forward for the consideration of the Most Noble the Governor in Council.

COPY.

Memorandum on the means of rendering the Lines of Native Troops defensible with three drawings and a sheet of references. Plates 73, 74, 75, 76, 77, 78.

That it may be seen whether it is desirable to make any arrangement for their better security, it is to be considered whether Lines as now existing are susceptible of defence, whether they could at the moment of emergency be fitted for it, and whether their capabilities would lead or would permit a Commanding Officer to make any good disposition for the protection of his Corps—all these enquiries may at once be answered in the negative.

2d. Attacks on Troops in their Lines are likely to proceed from two causes only, at out-stations from the surrounding Districts being in revolt; in the larger Stations from a spirit of insurrection bringing upon the Troops the population of

Digitized by Google

the large cities near which our principal Cantonments are established. In all possible cases where proper judgment was exercised, hostile bodies would be attacked, not waited for, but there are circumstances under which the Troops especially at out-posts may be assailed in their Lines, facility of surprise or a knowledge of the Detachments being weak serving as an inducement to the attack.

3d. In what way would such attempts probably be made, and in what way could, or is it to be anticipated, that a Commanding Officer would resist them, the present state of Lines considered.

4th. Insurgents whether trusting to surprise or the open onset of great numbers, would undoubtedly proceed against the flanks or rear of the Lines, perhaps burn them and from the cover found within them and about the neighbourhood endeavour to destroy the Troops whether still in disorder or formed on the Parade.

5th. What course in such circumstances would or could be pursued by the Commanding Officer, supposing that communication with the Bells of Arms had not been cut off and that the men had, had time to arm themselves, he yet could do nothing more than draw up the Troops in the open ground exposed to their concealed opponents and then send parties to dislodge the Insurgents from the ample cover under which they were protected. But this mode of making a defence though the only one now feasible, gives to irregular assailants the benefit of the sole description of hostile operation in which they are dangerous, while it subjects the Troops to the loss attendant upon the attack of enemies under shelter, whereas under any reasonable arrangements the advantage in this respect should be with the Troops—In detailing this possible hazard to Regiments, I have only assumed what cannot be doubted viz. that Picquets fixed at long intervals as they generally are, cannot prevent any entrance into the Lines by assailants depending on either surprise or force—To the preceding description of the insecurity of the Lines, is to be added the risk of the men being altogether debarred the possession of their Arms, since the danger of their being so, is evident, as the unexpected rush of a hundred men would seal up the Kotes and keep the weak Quarter guard shut into their shed

Digitized by Google

6th. It will I imagine be conceded that this defenceless state of the Lines should not be perpetuated if easily remediable, and that it is desirable to correct the existing defects, if the means be not difficult or expensive. They are I conceive, neither, and are as applicable to existing as to projected Lines.

7th. The conditions to be sought in Lines are,

1st. That there should be one safe main-post.

2d. That, that post should command access to the Bells, and at pleasure give or withhold possession of the Arms.

3d. That the buildings should be so disposed and adapted, as to keep in safety and ready both against secret and open attack, whatever is requisite for the defensive or offensive efforts of the Troops.

4th. That these indispensable Guards and Depôts should be so arranged as to compose, or to be capable of connection into a post or position, affording a safe place of assemblage of the men for forming to attack opponents or for resisting them if the Troops are reduced to the defensive.

8th. In the accompanying Drawings and the explanations, the attainments of these objects is shown roughly but sufficiently to permit of their being understood any details not separately specified. It will be perceived also that there may be adopted, either a part or the whole of the project, any one or two or the entire of the conditions being complied with in the execution.

AGRA, 12*th October* 1843. } (Signed) EDWARD SMITH, Major *Superintending Engineer C. P.*

No. 74. Plan of Lines as usually seen.
Nos. 75 and 76. Plan of Lines as they may be improved for defence.

Digitized by Google

References and Explanations.

a Quarter guard increased to accommodate 50 men within its walls to be loop holed. The loop holed walls thrown out at its rear and front would give cover for a considerable number in addition; within this redan 2 Guns might also be placed, its flanks command the entrances to the Bells of Arms. The Guns might also be used from within the Quarter guard. The building should contain 10 rounds of Ammunition for the Regiment and spare Arms for 100 men, for these last items of Provision the reasons are obvious.

b. Bells of arms to be loop holed, strong doors to be given.

c. Serjeant's houses to be loop holed also; by having a deposit of a few thousand bricks at hand, the verandahs &c. could in an hour be furnished with breast walls and good posts be formed.

d. The huts of the men for 70 or 100 feet in depth to be freed of irregularities and to be loop holed having no other roofs than tiles. They might remain occupied by the men as at present.

e. An open space by which the loop holed huts is separated from the rest of the Lines.

f. Covered place of assembly for the Troops, a few men sheltered in *a. b. c. d.* would protect the formation of the Troops in *f*

gg. If the Troops had to leave under protection, a number of followers &c., or if unable to drive the enemy off, they were obliged to cover themselves they would obtain defensible Lines by running the Trenches G. G. G. &c., work that may be done roughly in a few hours and be subsequently strengthened. Trees might be planted in such Lines as *h. h.* so as to be formed into abbatiés by the ready act of felling them where they stood.

Digitized by Google

The same arrangement though not so easily, may be made in Lines of the older construction. The only measure of any expence in the alteration is in the increase of the Quarter guard. Lines altered on the plan would for ordinary purposes of accommodation and duty, remain at least as convenient as at present, while they would have the advantage of being defensible at the moment and convertible by a few hours work into posts of some security.

The measure of protecting the entire Lines has not been here adverted to, chiefly because it is liable to this objection, that the whole force nearly would be occupied in defending so large a space

(Signed) EDWARD SMITH, Major,

Superintending Engineer C. P.

ARMING OF BOATS.

The numerous alterations and very great improvements which have been lately made in arming Vessels in Her Majesty's Navy, has rendered it advisable to make similar improvements in arming Boats attached to Ships and War Steamers, and the following is the proportion of guns and carriages which have been resolved upon by the authorities, to be used in the boats of each class of ship and vessel in her Majesty's service —The ammunition and stores for the same to be prepared at Woolwich, similar to a plan submitted by Colonel Lacy, Inspector of the Royal Carriage Department; Lieutenant Colonel Dundas, C. B. Inspector of Artillery; and the Store-keeper and deputy Storekeeper at the Royal Arsenal; and approved by Captain Sir Thomas Hastings, of the "Excellent" gunnery ship, at Portsmouth.

Boats of First, Second, and Third Rates.—One 24 Pdr. brass howitzer, weighing 13 cwt. on field marine travelling carriage complete, with limber; top to be used in boats, fitted also for mounting and dismounting on an inclined plane, and if it cannot be fitted for both purposes, a second top will be required —One 6 pdr. light brass gun, six cwt. on field marine travelling carriage complete, with limber; top to be used in boat, with bottom to receive the top for firing into ship's top. One 24 pdr. iron carronade, 13 cwt.; top to be

Digitized by Google

used in a boat for mounting and dismounting on an inclined plane. Two 12 pdr. iron carronades, six cwt. each ; top to be used in boat for each, and one bottom in each boat to receive the top, for firing into ship's tops.

Boats of Fourth and Fifth Rates —One 6 pdr, light brass gun six cwt. on field marine travelling carriage complete with limber ; top to be used in boat, with bottom to receive the top, for firing into ship's tops ;—Two 18 pdr. iron carronades, 10 cwt, each ; top to be used in boat, fitted for mounting and dismounting on an inclined plane. Two 12 pdr. iron carronades six cwt. each ; top to be used in boat, with bottom to receive the top, for firing into ship's tops.

Boats of Sixth Rates,—One 6 pdr. light brass gun, on field marine travelling carriage complete, with limber ; top to be used in boat, with bottom to receive the top, for firing into ship's tops.—The brass 6 pdr. field piece is not to be supplied to any sixth rate of a class below that of the " Vestal." Two 12 pdr. carronades, six cwt. each, top to be used for each in boat, with one bottom to receive top, for firing into ship's tops.

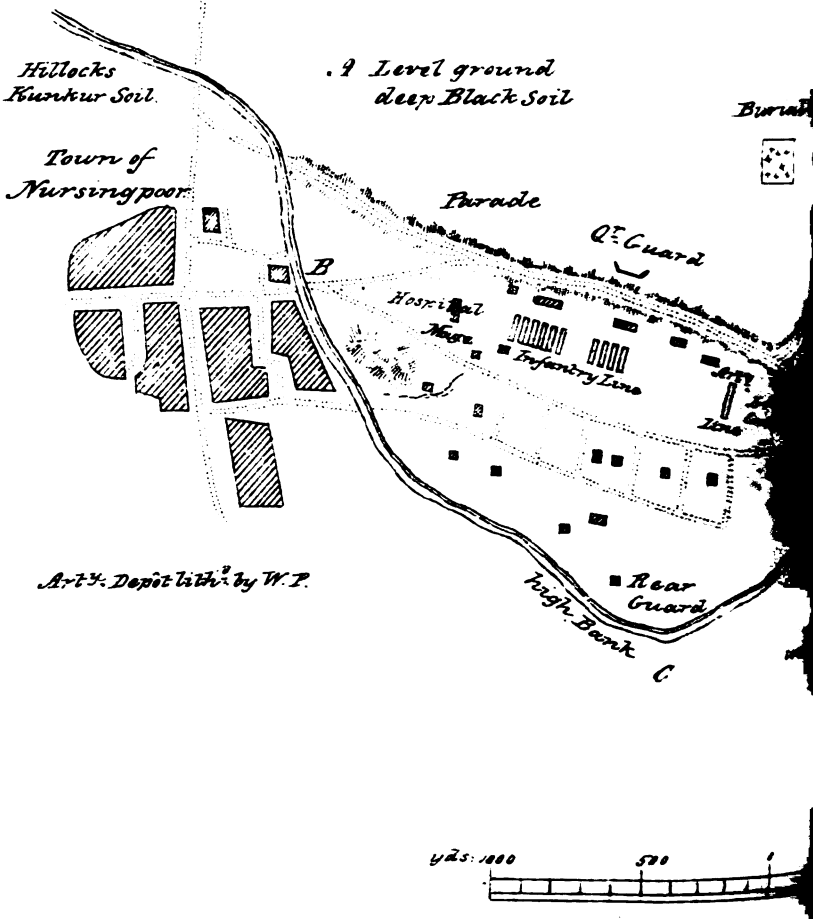
Boats of First and Second Class War Steamers.—One 6 pdr. light brass gun, six cwt. ou field marine travelling carriage complete, with limber; top to be used in boat, with bottom to receive the top, for firing into ship's tops—Two 24 pdr. iron carronades, 13 cwt. each, with transporting slides, and top for ditto, to be used in paddle box boats. The carronades are to be mounted on transporting carriages, and attached to the side of the ship for alarm and signal guns, and for service in paddle box boats.

Boats of Third Class War Steamers.—One 12 pdr. iron carronade, six cwt., top to be used in boat, with bottom to receive the top, for firing into ship's tops. The side guns of the third class steamers being lighter, may be used for the above purposes when the 12 pdr. carronade is not sufficient.

Boats of Sloops and Brigs of War. One 12 pdr. iron carronade, six cwt. ; top to be used in boat, with bottom to receive the top, for firing into ship's tops. Any small vessel not carrying a pinnance may be supplied with a 12 or 6 pdr. carronade, according to the capacity of the boat.

Digitized by Google

Digitized by Google



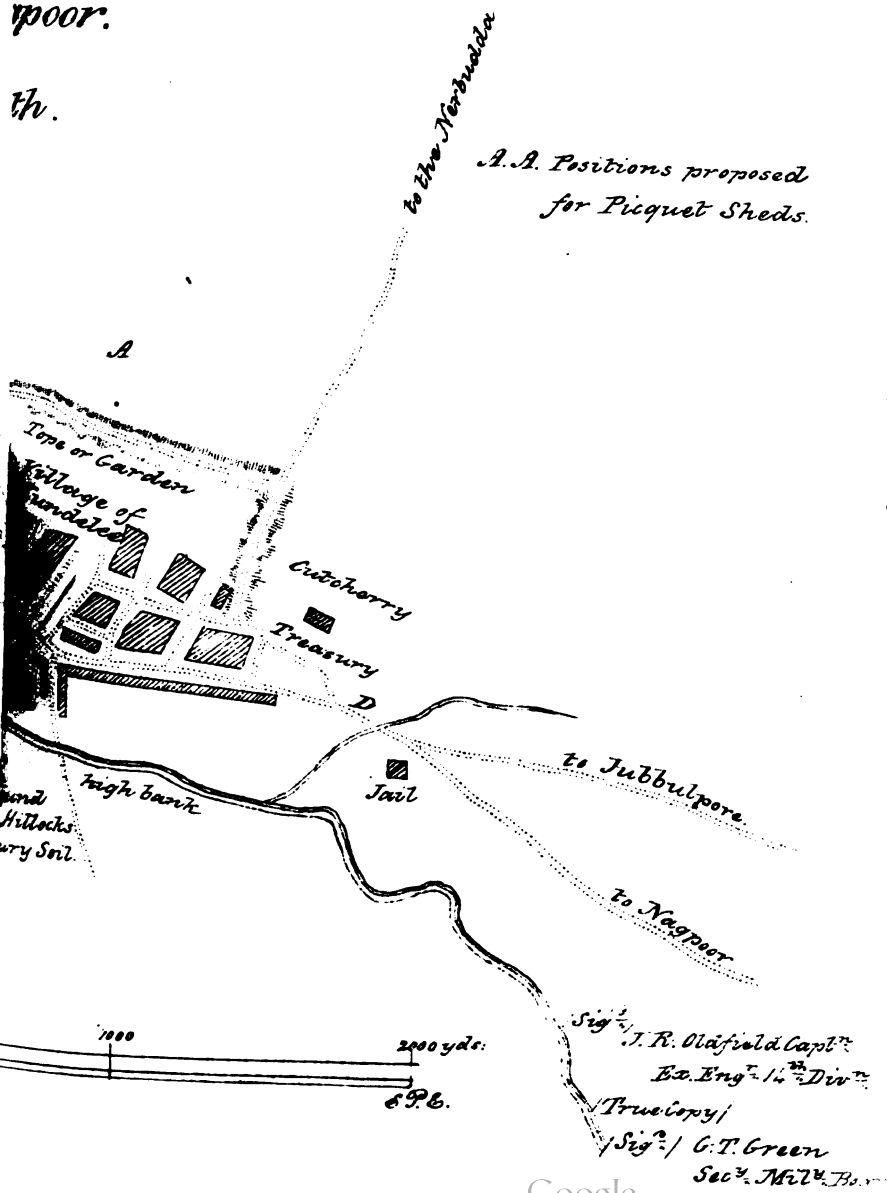
Art.y. Depot lith.d by W.P.

neous.

Plate 73.

h shewing
Cantonment
poor.

th.



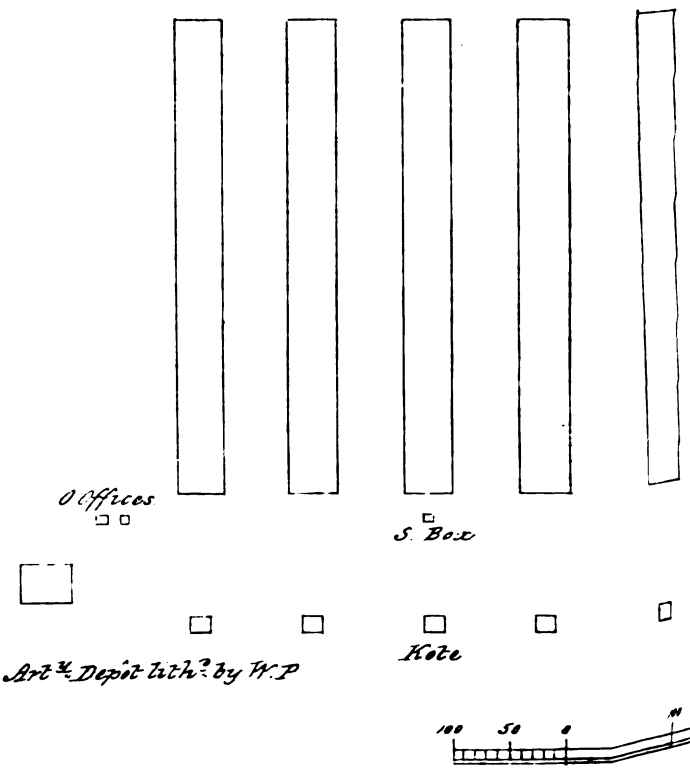
Digitized by Google

Digitized by Google

Digitized by Google

Miscell

Plan of Lines



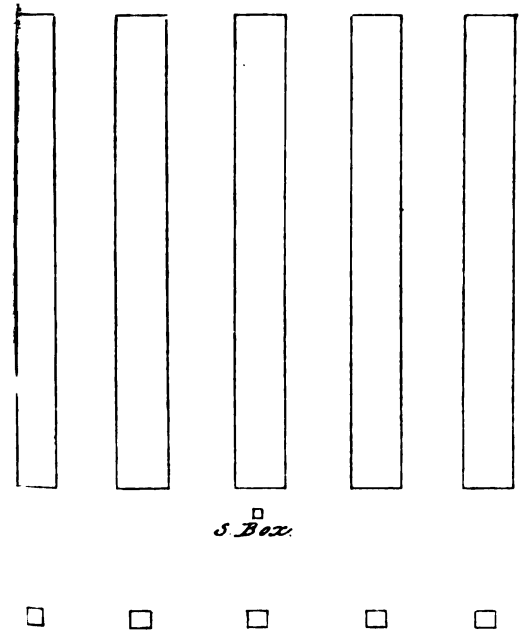
Art.y Depot lith.d by W.P
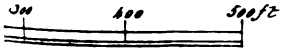
Digitized by Google

vus.

Plate 74.

w usually seen.





/Signed/
Edwd. Smith Major
Supt. Engr. C.P.

/True Copy/
/Signed/ G.T. Green
Sec'y. Mil'y. Board.

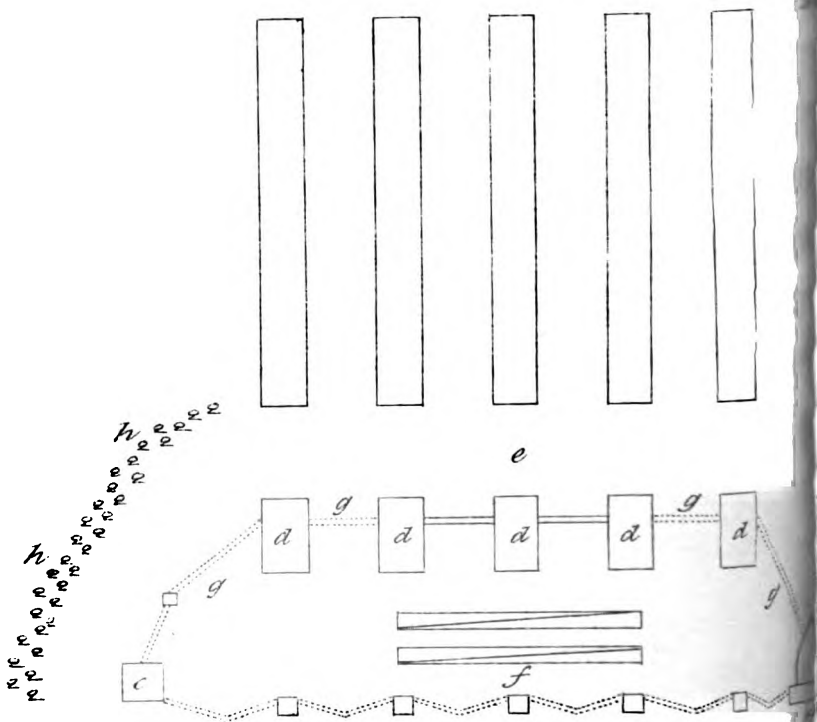
Digitized by Google

Digitized by Google

Digitized by Google

Miscel

Plan of Lines as they



Art^y. Depôt lith^r. by W. P.

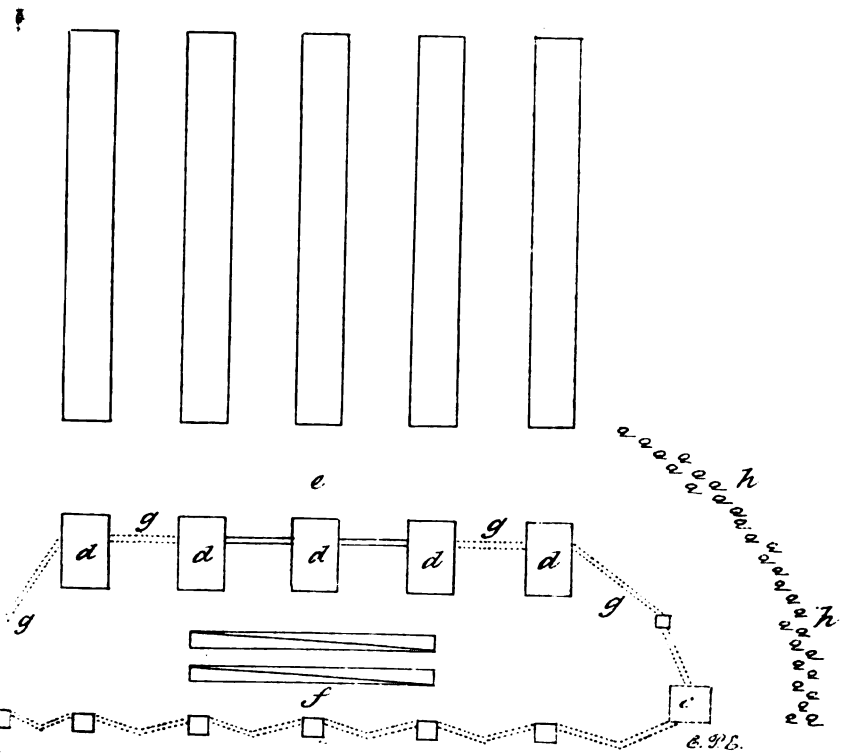


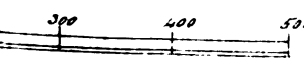
Digitized by Google

eous.

Plate 75.

be improved for Defence.





/Signed/ Edw.d Smith Major
Sup.g Eng.r C.P.

/True Copy/
/Signed/ G.H. Green
Sec.y Mil.y Board

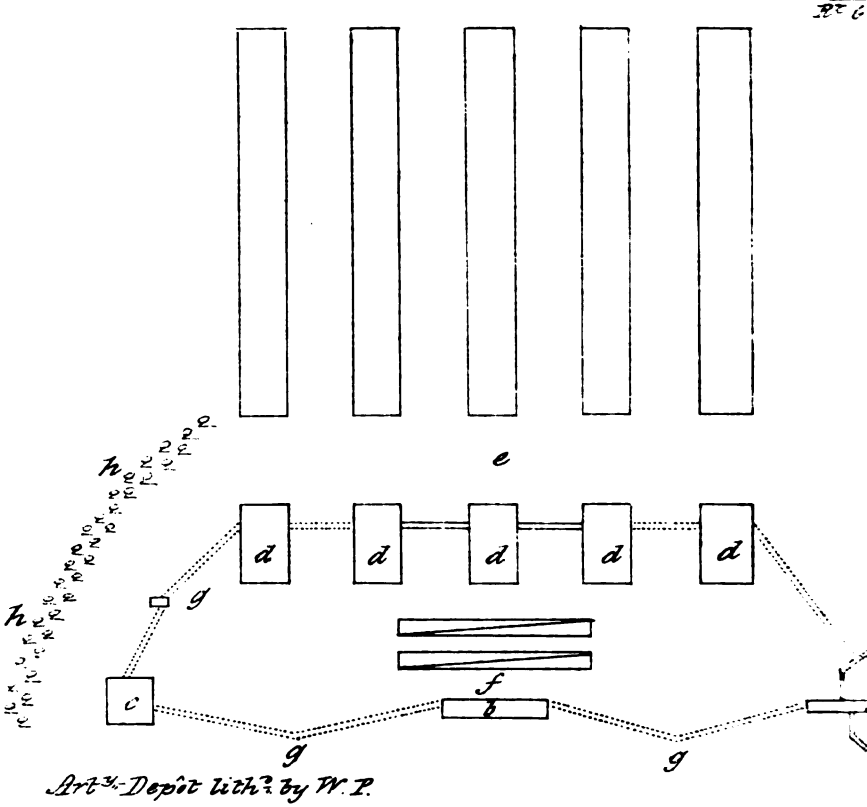
Digitized by Google

Digitized by Google

Digitized by Google

Miscella

Plan of Lines as they may



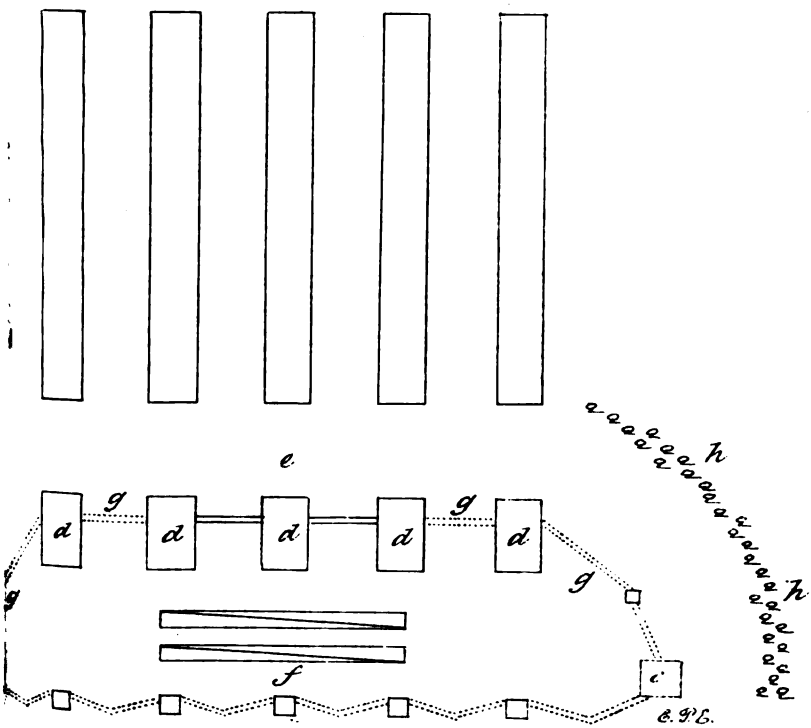
Art^y. Depôt lith^r. by W. P.

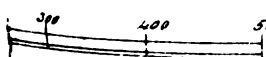
Digitized by Google

eous.

Plate 75.

be improved for Defence.





/Signed/ Edw.d Smith Major
Sup.g Eng.r C.P.

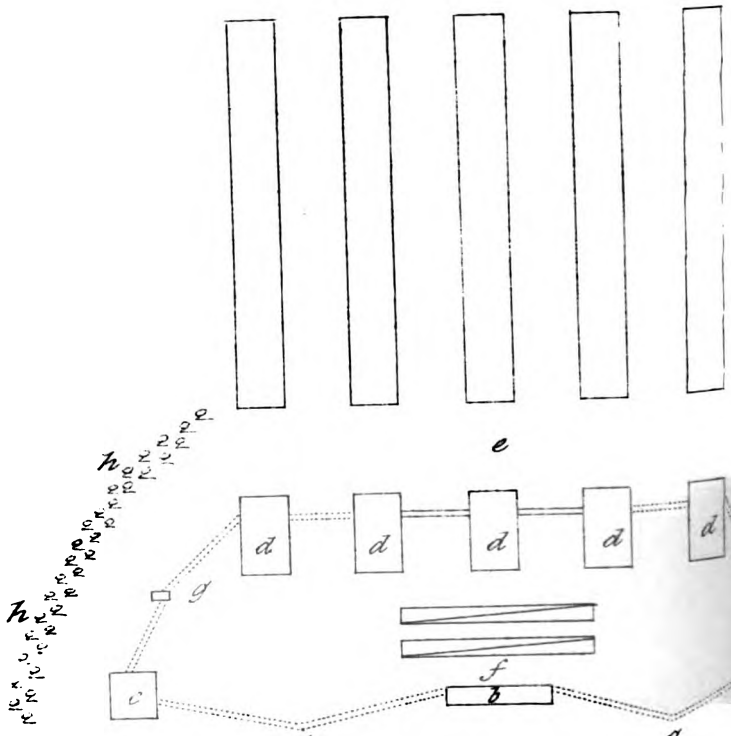
/True Copy/
/Signed/ G.H. Green
Sec.y Mil.y Board

Digitized by Google

Digitized by Google

Digitized by Google

Plan of Lines as they ma



Art^{y}-Depot lith^{s} by W. P.

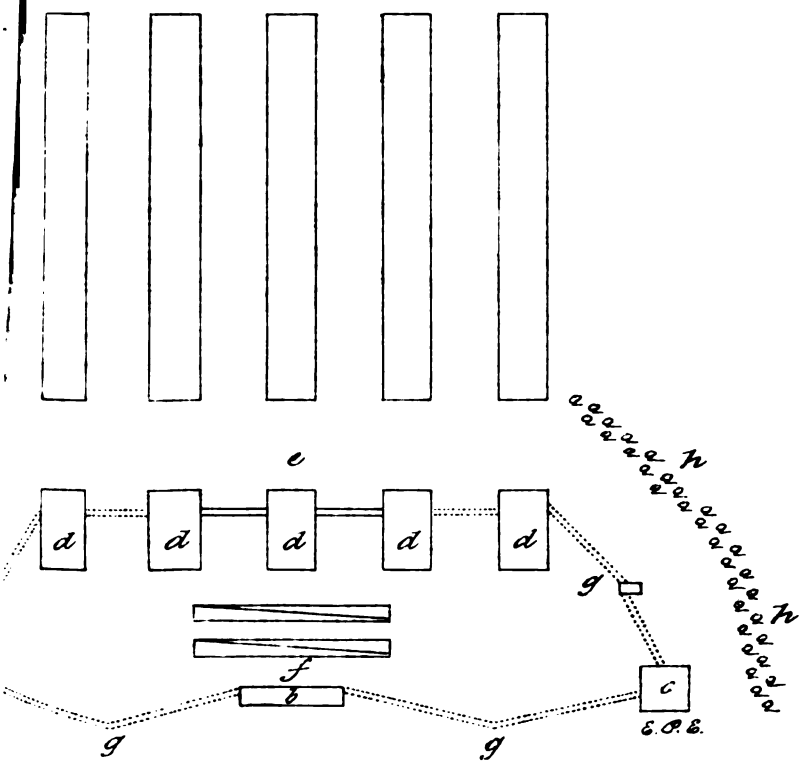


Digitized by Google

ous.

Plate 76.

improved for Defence.



/Signed/ Edw^d. Smith Major
Sup^d. Eng^r. C.P.

300 400 500ft. /True Copy/

/Sig^d./ G.T. Green
Sec^y. Mil^y. Board.

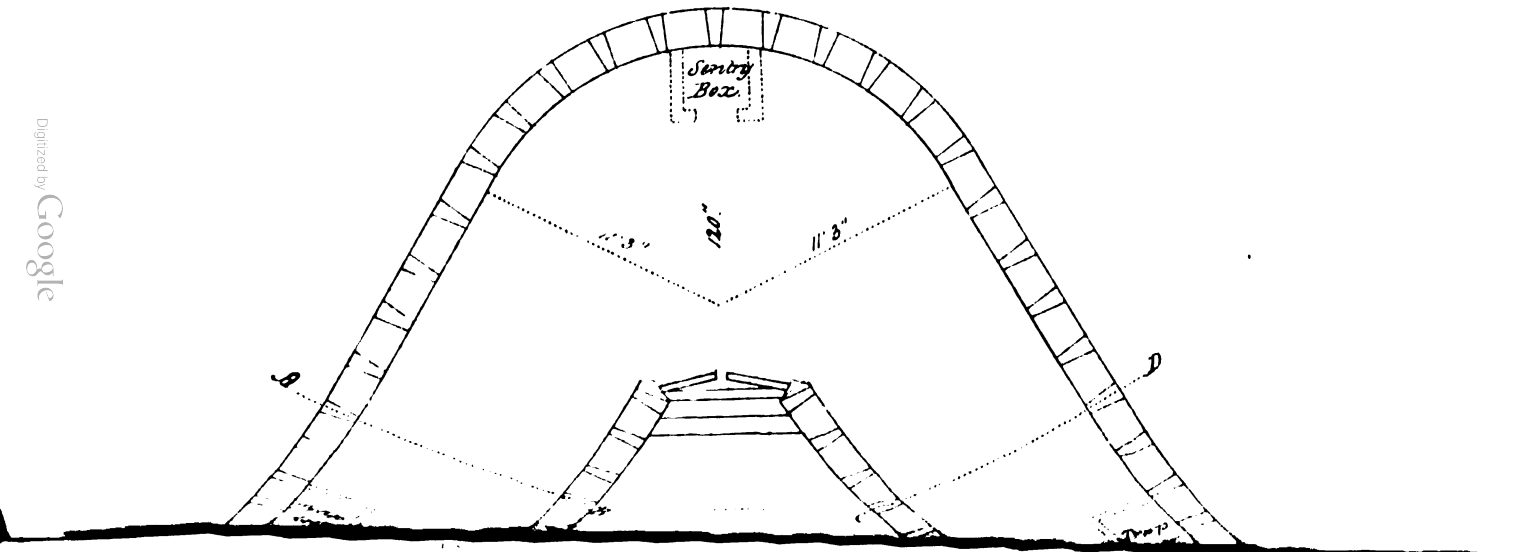
Digitized by Google

Digitized by Google

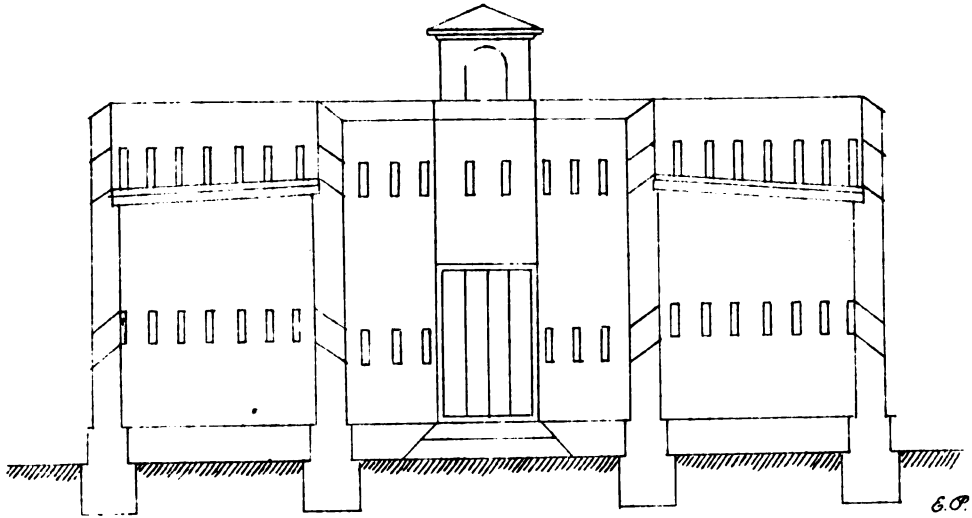
Digitized by Google

Miscellaneous.

Plan of a Defensible Picquet Shed for 1 N. Officer, 2 Havrs & 24 Sepoys.



Digitized by Google



E.P.E.

S.P.R. Depot lith.d by W.P.

Section & Elevation A.B.C.D.

10 5 0 10 20 30 feet.

/Sig.d/ J.R. Oldfield Capt.n R.E.
Ex. Engr. 11th Div.n

/True Copy/ /Sig.d/ G.T. Green

Digitized by Google

Digitized by Google

Digitized by Google

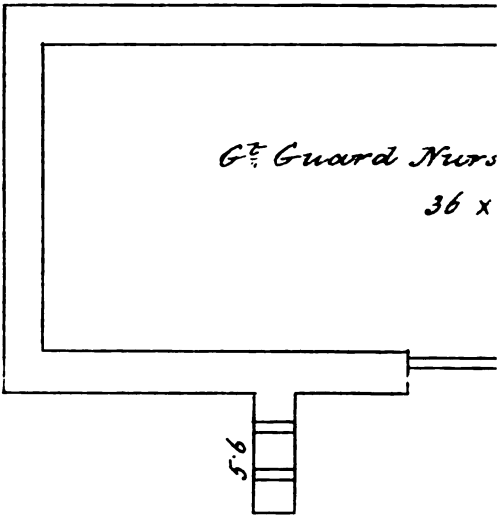
Museum

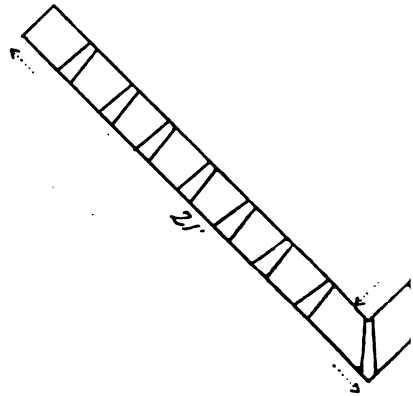
Proposed Loop holed Screen W
to protect the

Measurements.

21 + 20 + 2 + 5·5 = 52 Length of Wall.

L	B	D	feet	
52	x 2	x 2·5	= 260	Foundation.
52	x 15	x 6	= 468	Superstructure.





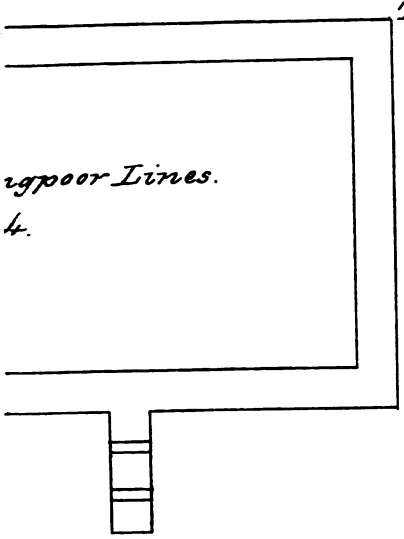


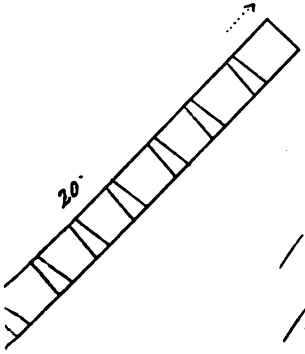
Art. Depot lith. & by W. P.

l in front of Guard Room
ntrance.

Estimate.

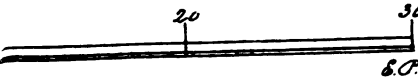
	R. a. P
50 feet Foundation of burnt brick & lime Mortar @ 10/	26 . 0 . 0
68 Sup. of Do: with loop holes @ 12	56 . 2 . 6
Total	82 . 2 . 6





/Signed/ J. R. Oldfield Capt^n
E^x Eng^r 1st Division

/True Copy/
/Sig^d/ G. T. Green
Sec^y Mil^y Board.



Digitized by Google

Digitized by Google

BENGAL FIELD BATTERIES.

Establishment and Allowances of a Company of European Foot Artillery in Garrison or Cantonments.

Establishment.		Pay at and below Allahabad.			Pay above Allahabad.		
1	Staff Serjeant, ...	24	14		26	7	4
6	Serjeants, ...	24	14		26	7	4
6	Corporals. { Above 14 years' service, ..	22	13	5	24	6	9
	{ Under ditto ..	20	5	8	21	15	0
6	Bombardiers. { Above 14 years' service, ..	20	13	5	22	6	9
	{ Under ditto ..	18	5	8	19	15	0
2	Buglers, ...	16	9	4	18	2	8
60	Gunners. { Above 14 years' service, ..	14	10	11	16	4	2
	{ Under ditto ..	12	3	2	13	12	6
	Pay Serjeant, }	7	0	0	7	0	0
	Staff Serjeant, } Non-Effective.....	5	12	0	5	12	0

	Gun Lascar Details.	Batta.			Pay.			Total.		
1	Subadar.	15	0	0	44	0	0	59	0	0
2	Havildar.	2	0	0	7	8	0	9	8	0
2	Naicks.	2	0	0	6	0	0	8	0	0
31	Privates. { above 20 years Service....	1	0	0	6	12	0	7	12	0
	{ ,, 16 0 0 ..	1	0	0	5	12	0	6	12	0
	{ under 16 0 0 ..	1	0	0	4	12	0	5	12	0
2	Puckallies.	0	0	0	0	0	0	9	0	0
2	Sweepers.	0	0	0	0	0	0	4	0	0
	Allowances for Comg. Compy.	..	...	..	...	..	..	60	0	0

Digitized by Google

Establishment and Allowances of a Company Native Foot Artillery in Garrison or Cantonments.

Establisht.		Batta.			Pay.			Total of each.		
		R	A.	P.	R.	A.	P.	R.	A.	P.
1	Subadar	15	0	0	52	0		67	0	0
2	Jemadars.....	7	8	0	17	0		24	8	0
6	Havildars	5	0	0	9	0		14	0	0
6	Naicks.....	5	0	0	7	0		12	0	0
88	Privates { above 20 yrs. Ser.	1	8	0	7	8		9	0	0
	16 „	1	8	0	6	8		8	0	0
	under 16 „	1	8	0	5	8		7	0	0
1	Tent Lascar	1	0	0	4	12		5	12	0
1	Bheestie.....	1	0	0	4	0		5	0	0
	Pay Havildar.....	0	0	0	0	0		5	0	0
	Brigade Havildar.....	0	0	0	0	0		2	0	0
	Allowance for Commanding the Company.....	0	0	0	0	0		50	0	0

Digitized by Google

Establishment and Allowances of a Horse Field Battery.

Establisht.		Staff Pay.	Pay.			Half batta			Total of each		
	Captain Horse Allowance, ...								60	0	0
	Subaltern ditto.								30	0	0
1	Rough Rider and Farrier Serjeant Effective, ...	* 14							0	0	0
1	Assistant Farrier and Saddler Non-effective, ...	10							10	0	0
2	Havildars, ...		7	8	0	2	0	0	9	8	0
2	Naicks, ...		6	0	0	2	0	0	8	0	0
54	Syce Drivers, ...		5	0	0	1	0	0	6	0	0
44	Syces, ...		4	0	0	0	0	0	4	0	0
98	Grass Cutters, ...		3	8	0	0	0	0	3	8	0
1	Bheestie, ...		5	0	0	0	0	0	5	0	0
1	Native Farrier, ...		9	0	0	0	0	0	9	0	0
1	Moochie, ...		5	0	0	0	0	0	5	0	0
1	Maistry Smith, ...		12	0	0	0	0	0	12	0	0
2	Filemen, ...		7	0	0	0	0	0	7	0	0
2	Firemen, ...		7	0	0	0	0	0	7	0	0
2	Hammermen, ...		6	0	0	0	0	0	6	0	0
1	Maistry Carpenter		14	0	0	0	0	0	14	0	0
2	Workmen Carpenters, ...		10	0	0	0	0	0	10	0	0
	Contingent Gun allowance for 6 Guns including 6 Ammunition Waggons, ...								90	0	0
	Contingent allowance for 1 Store Cart, ...								5	0	0
	Allowance for shoeing 98 Horses at each Rs.								2	0	0
	„ Repairs 93 Harness, Saddles, &c.								1	8	0
	„ Repairs of 5 Saddles do. ...								1	0	0
	„ four Gram Pots, ...								20	0	0
	„ Cavessons and Cotton Ropes, ...								5	0	0
	Pay for 3 Bullock Drivers for the Store Cart each								4	0	0

* With Foot Artillery Pay as Serjeant, also batta if not furnished with rations.

Digitized by Google

Extra Batta when in the Field or Marching.

		R.	A.	P.
2	Havildars..... each	2	0	0
2	Naicks.....	2	0	0
54	Syce Drivers.....	1	0	0
44	Syces.....	1	0	0
98	Grass Cutters.....	1	0	0
1	Native Farrier	1	0	0
1	Moochie.....	2	0	0
1	Bheestie.....	1	0	0
1	Maistry Smith.....	3	0	0
2	Filemen..... each	2	0	0
2	Firemen.....	2	0	0
2	Hammermen.....	2	0	0
1	Maistry Carpenter.....	3	0	0
2	Workmen Carpenters ..... each	3	0	0
	Contingent allowance for 4 additional Waggons.....	20	0	0
3	Bullock Drivers..... each	1	0	0

Digitized by Google

Establishment and Allowances of a Field Battery of Elephant draft G. O. C. C. 7th September 1842, 15*th May and* 21*st July* 1843, *and 5th June* 1844.

Estabt		Pay and Allowances.
		Rupee s.
	Captain. } Serving with the Battery draw.	60
	Subaltern. } Horse allowance.....	30
1	ElephantSerjeant (non-effective).....	20
1	Jemadar Mahout.....	10
17	Mahouts.....each.	7
1	Sirdar Coolie.....	5
17	Coolies.....each.	4
1	Bheestie.....	5
1	Moochie	5
	Allowance for repairs of 15 sets of Elephant harness at 6 rupees per set.....	90
	Allowance for tar, grease &c. and for repairs of 13 Carriages and Battery Stores.....	95
	TRAIN ESTABLISHMENT.	
1	Maistry Smith.....	12
2	Filemen.....each	7
2	Firemen.....	7
2	Hammermen.....	6
1	Maistry Carpenter.....	14
2	Carpenters.....each.	10
	ADDITIONAL ALLOWANCE WHEN IN THE FIELD.	
1	Jemadar Mahout.....	1
15	Mahouts.....each.	1
1	Sirdar Coolie.....	1
15	Coolies.....each.	1
1	Maistry Smith.....	3
2	Filemen.....each.	2
2	Firemen.....	2
2	Hammermen.....	2
1	Maistry Carpenter	3
2	Carpenters.....each.	3

Digitized by Google

Establishment and Allowance of a Camel Battery.

Establishment.	Pay and Allowanees.	Pay.			Batta.			Total of each.		
	Captain } Serving with the Battery..							60	0	0
	Subaltern } draw Horse Allowance							30	0	0
1	Camel Serjeant....(Non-Effective)							20	0	0
4	Sirdars	7	0	0	2	0	0	9	0	0
65	Sowars.....	5	0	0	1	0	0	6	0	0
1	Bheestie.....	4	0	0	1	0	0	5	0	0
	Allowance for Mussallahs, Ghee &c for 70 Camels, at each.....							2	8	0
	Ditto for Stationery.....							10	0	0
	TRAIN ESTABLISHMENT.									
1	Maistry Smith.....	0	0	0	0	0	0	12	0	0
2	Filemen.....	0	0	0	0	0	0	7	0	0
2	Firemen....	0	0	0	0	0	0	7	0	0
2	Hammermen.....	0	0	0	0	0	0	6	0	0
1	Maistry Carpenter.....	0	0	0	0	0	0	14	0	0
2	Carpenters..... ..... each	0	0	0	0	0	0	10	0	0
	Contingent allowance for 6 Guns including 6 Waggons at each.. }	0	0	0	0	0	0	15	0	0
	Ditto for 1 Store Cart.....	0	0	0	0	0	0	5	0	0
1	Gumashta...	0	0	0	0	0	0	20	0	0
1	Pulladar.....	0	0	0	0	0	0	4	0	0
1	Chuprassee.....	0	0	0	0	0	0	4	0	0
32	Additional Sowars allowed on actual Service..... ..... }	5	0	0	2	0	0	7	0	0
	EXTRA BATTA WHEN IN THE FIELD OR MARCHING.									
4	Subadars..... ....each	0	0	0	0	0	0	2	0	0
65	Sowars..... .. .. „	0	0	0	0	0	0	1	0	0
1	Bheestie	0	0	0	0	0	0	1	0	0
1	Maistry Smith..	0	0	0	0	0	0	3	0	0
2	Filemen ....each	0	0	0	0	0	0	2	0	0
2	Firemen..... ..... „	0	0	0	0	0	0	2	0	0
2	Hammermen ..... „	0	0	0	0	0	0	2	0	0
1	Maistry Carpenter.....	0	0	0	0	0	0	3	0	0
2	Carpenters..... ..... each	0	0	0	0	0	0	3	0	0
	Contingent allowance for 1 additional store cart... ... . }	0	0	0	0	0	0	5	0	0
	Ditto for spare waggons. .....each	0	0	0	0	0	0	5	0	0
	Allowance for Mussallahs, Ghee for 32 additional Camels, at each.....	0	0	0	0	0	0	2	8	0

Digitized by Google

METHOD OF SEASONING SAUL TIMBER IN BENGAL.

Letter No. 4795, *from the Secretary to the Military Board, Calcutta, to the Secretary to the Military Board, Madras, dated Fort William, 8th November,* 1844.

In continuation of my letter No. 4233 of the 14th ultimo, I am directed by the Military Board to transmit the annexed copy of a letter No. 127, dated the 23rd October 1844, from Major Abbott, Agent for Gun Carriages at Futtehghur, respecting the Rules observed in the Gun Carriage Agency, for the seasoning Saul materials.

Letter No. 127, *from Major* A. ABBOTT, *Agent for Gun Carriages, to the Secretary to the Military Board, Calcutta, dated Futtehghur, 23d October* 1844.

I have the honor to acknowledge your letter No. 4232, regarding the Rules observed in seasoning Saul material.

I have the pleasure to forward a detail of the rules which I have adopted, since I took charge of the Agency, and which promise to be quite successful. The Madras Agent will be able to judge whether the precautions, observed in the hot and dry climate of Futtehghur, are necessary in the more temperate climate of his own Presidency.

It seems probable that the Saul used by the Madras Agent, was not sufficiently seasoned, and this is an evil which must always attend any extensive change in the patterns of Carriages.

Carriages built of the very best Saul that can be obtained, will always be liable to cracks and blemishes; and Officers must not expect a Saul Carriage to look so well as one built of Sissoo or Teak, but it is far stronger, and will never fail in the hour of need, as I have seen the others fail.

Remarks on the seasoning of Saul materials for Ordnance purposes.

1st. The Saul timbers brought for sale to Futtehghur, are always full of sap.

2d. Some chips cut from the centre of a large timber, that had been 2 years in the Fort, lost ⅓ of their weight, after

Digitized by Google

being exposed for a few hours to the heat of the sun, and a plank 12 inches broad was reduced to 11·475 by a few days exposure on a puka terrace.

3d. It is extremely difficult to season large blocks of such wood, in a hot and dry climate; and all the large Saul material, which I found in this Agency, was disfigured by splits that rendered it scarcely fit for use.

4th. The method which I have adopted to preserve large material from ruin, is at present merely experimental, but it promises to answer well.

5th. As soon as a large piece of half-wrought material is obtained from a tree, it is covered with 2 layers of cow-dung, and earth, and lodged in the seasoning shed; a lofty building with good doors to exclude the dry wind (a.)

6th. During very hot weather, and while dry winds prevail, the piles of large material are covered with old linen (obtained from condemned tents.) The rapid desiccation of the material is thus checked, and a number of beams obtained in 1843, and which have been thus protected, shew very few cracks indeed.

7th. Smaller material is not so liable to crack because it dries more equally; and the piece of plank, on which I tried the experiment, to ascertain the amount of shrinkage, did not crack at all.

8th. There is no particular mark, by which it can be known that Saul is perfectly seasoned, but if the following rules be attended to, there will be few complaints on this head.

9th. A tree, whose girth (measured at the centre) is 5 feet or thereabout, must be allowed to lie 2 years, before it can be considered fit for sawing into half-wrought.

10th. A tree of 6 or 7 feet girth, should be 3 years before the saw is applied to it.

(a.) Vide note 11 at foot of page 183—3d Edition, Tregold's Carpentry, a work which contains (as far as I am able to judge) most excellent rules for seasoning timber.

The time allowed by the table at page 194, is too short to dry timbers for joiners' work, in a temperate climate perhaps, but in India it will be found sufficient.

Digitized by Google

11th. The sawyers' yard at Futtehghur is opened about the 1st July and closed before the 1st of March of the following year. It is never opened during the hot winds.

12th. Small articles of Saul should remain in a half-wrought state at least 2 years; 9 and 6 pounder beams at least 3 years; and 12 and 24 pounder Howitzer beams 4 years, before they are used in the construction of Carriages.

(Signed) A. ABBOTT, Major,

Gun Carriage Agent.

TIMBER OF THE TENASSERIM PROVINCES.

Letter No. 240, *from* Captain G. W. Y. Simpson, *Commanding Artillery Tenasserim Provinces, to the Director Artillery Depôt, dated* 16*th December*, 1844.

I do myself the honor to forward herewith a box of specimens of the various descriptions of Teak timber procurable in these Provinces together with a report on their respective qualities, under the impression that a table of this nature at the present time, when there is so great a dearth of good Teak, may be of public service.

2. The specimens were very carefully selected from Mr. Sutherland's extensive timber yard, and comprise every description of Teak timber now obtainable in the Moulmein market.

3. The Zemi timber realises a higher price than the Thounggeen, but from the results of many experiments on the two woods my own impression is that the Thounggeen is the better timber.

4. The objectional character of the timber of these Provinces arises chiefly from its being killed at improper seasons, when in fact the tree is almost bursting with sap, the greater portion of which being unable to escape, owing to the vessels becoming hardened and choked at the surface, is confined to the log, forming extensive sap-pools only to be discovered when the timber is worked up; exhibiting no trace whatever externally of the unsoundness within.

5. The forest workers are however now becoming far more careful in this respect, and it may be presumed that a more trustworthy description of timber will henceforth be in the market.

Digitized by Google

6. Another cause, want of capital, has also contributed to fill the Moulmein market with a coarse loose fibred timber, of very rapid growth and found in wet localities close to the river, from whence it can be rafted up to Moulmein at comparatively little expense, the parties not having the means to enable to kill and bring to market the Teak, which is found at some distance from the river in dry exposed localities, and of much slower growth. This latter timber is fine grained, with great tenacity of fibre, rather light in colour, and of greater specific gravity than the Teak from most sites.

7. It would appear, on enquiry, that the above causes, and not the absence of good Teak in the Tenasserim Provinces, have brought the timber shipped at Moulmein into some disrepute, but Government might, beyond question, by its agent making careful selection (testing each log) and paying a liberal price, obtain woods here fit for any purpose whatever.

8. I have enclosed herewith the results of test on two good specimens of Padowk (seasoned.) Its great weight and extreme tendency to grow knotty, together with its somewhat limited dimensions, so far as I can learn, tend to render this wood of less value than it would otherwise be.

9. The Anan test was made on a very bad specimen (dead tree) none other being procurable just now, but from what I have seen of this wood I certainly consider it one of the best in the Provinces.

Digitized by Google

PERIMENTS on the Strength of the undermentioned various specimens of Teak and other Timber produced in e Tenasserim Provinces, the weights being applied by half hundred weights.

Date.	Number marked on Specimen.	Number tested.	NATURE OF WOOD.	Specimens. Length. Feet.	Dimensions square.	Weight of lbs.	ozs.	drs.	Deflection. 5 Minutes with 224 lbs.	5 Minutes with 448 lbs.	5 Minutes with 606 lbs.	5 Minutes with 830 lbs.	Broke with lbs. including weights of scales and Esses. Last weight. lbs.	Last curve of Deflection.	After Minutes.	Specific Gravity	Temperature of the water in which immersed 79.	REMARKS.
			TEAK TIMBER.		Ins.				224 Ins.	448 Ins.	672 Ins.	868 Ins.						
Sept	1	1	Young Thounggeen killed. .	3	1 1/2	2	0	12	1/4	1/2	1 1/6	1 1/8	884	1 1/20	1/4	·721		Long firm good fibre, well interlaced, but rather coarse.
,,	2	2	Zemi, very large.....	3	1 1/2	1	9	8	1/2	1 1/8	532-1 3/8	0	543	1 3/20	2	·776		Bad fibre, short and Carotty.
,,	3	3	Zemi large, burnt tree	3	1 1/2	1	10	8	1/16	3/4	642-1 5/8	0	665 1/3	1 1/8	3 1/4	·600		Firm fibre, not long, but sound.
,,	4	4	Thounggeen, young tree. . .	3	1 1/2	1	15	12	3/8	1/2	1 3/16	714-1 3/8	736 2/3	1 3/20	2	·727		Long, very good fibre.
,,	8	..	"*Padowk*" killed, seasoned.	3	1 1/2	2	14	8	1/4	1/2	1 1/16	1 1/4	930 1/4	1 1/8	3 1/2	1·018		Excellent fibre but specimen knotty
Sept	5	5	Thounggeen, dead tree, large	3	1 1/4	1	10	8	1/2	1 1/8	0	0	543 3/4	1 1/8	2 1/2	·581		Fibre long, but coarse and exhibiting a fine almost impalpable powder along the fibre.

Digitized by Google

Date.	Number marked on Specimen.	Number tested.	NATURE OF WOOD.	Length. Feet.	Dimensions Square.	Specimens. Weight of lbs.	ozs.	drs.	Deflection. 5 Minutes with 224 lbs.	5 Minutes with 408 lbs.	5 Minutes with 606 lbs.	5 Minutes with 830 lbs.	Broke with lbs. including weights of Scales and Esses. Last weight. lbs.	Last curve of Deflection.	After Minutes.	Specific Gravity Temperature of the water in which immersed 79	REMARKS.
15th Sept	6	6	Thounggeen, dead tree	3	1¼	1	10	8	1/16	1/8	0	0	59 4/4	1¼	2	·592	Long fibre, but not very strong.
,, ,,	7	7	Thounggeen, very large tree killed	3	1¼	1	14	0	5/16	6/16	7/8	1 7/8	868 1/8	1 7/8	1 1/4	·696	Very good fibre, broke with long splinters.
,, ,,	8	8	Thounggeen, large tree killed	3	1¼	1	8	0	3/16	1 1/16	0	0	459 3/4	1 1/16	1 1/4	·569	Short fibre, no splinters.
,, ,,	9	9	Thounggeen, young tree killed	3	1¼	1	12	0	2/16	1 1/16	0	0	597 3/4	2	1	·644	Very good fibre, promised a better result.
,, ,,	10	10	Thounggeen, dead tree	3	1¼	1	12	8	5/16	1 1/16	0	0	602 3/4	1¼	¼	·590	Good fibre, specimen imperfect.
,, ,,	11	11	Thounggeen, large tree killed	3	1¼	2	0	0	2/16	4/16	1	1 1/8	984 1/4	1 7/8	4	·724	Particularly long, tenacious fibre, broke gradually.
,, ,,	12	12	Thounggeen, large tree killed	3	1¼	1	14	8	3/16	6/16	7/8	1 1/8	912 1/4	1 1/4	1 1/4	·693	Very good strong fibre.
,, ,,	13	13	Thounggeen, dead tree	3	1¼	1	13	12	4/16	4/16	1 1/16	0	721 1/4	1 7/8	1 7/8	·635	Very fine fibre, and had it been killed Tree, would have given good result.
,, ,,	14	14	Zemi large, killed by fire	3	1¼	1	13	4	2/16	0	0	0	280 3/4	7/8	1/4	·650	Short, dry fibre, broke short.

Digitized by Google

7th Oct.	22	15	Best specimen of Zemi Timbers.....	3	1¼	2	1	0	7/16	1 5/16	0	0	573⅓	1	1	·688	Coarse fibre, killed when full of Sap
,, ,,	23	16	Best specimen of Zemi.	3	1¼	1	14	8	4/8	1	0	0	461⅓	1	1½	·640	Do. do. do. do. do.
,, ,,	16	17	Thounggeen, dead tree.. ...	3	1¼	2	0	8	2/8	4/8	5/8	1	925⅓	1⅝	½	·706	Very long fibre, long splintering fracture.
,, ,,	19	18	Thounggeen, very large tree.	3	1¼	1	15	8	2/8	4/8	5/8	1 5/16	913⅓	1	1	·706	Very good fibre, long fracture.
,, ,,	15	19	Thounggeen, young killed tree, best specimen....	3	1¼	2	1		5/16	4/8	1/16	1 1/16	929	1⅛	¼	·687	Excellent fibre, long and tenacious killed when full of Sap.
,, ,,	17	20	Thounggeen, killed tree....	3	1¼	1	12	8	7/16	6/8	1/16	0	743¼	1⅜	¼	·692	Very good fibre, Tree killed when full of Sap.
,, ,,	18	21	Thounggeen, killed.....	3	1¼	1	14	8	5/16	4/8	1/16	1 5/16	857¼	1 5/16	1½	·695	Good fibre, long and tenacious.
,, ,,	21	22	Best specimen of Zemi	3	1¼	1	15	8	4/8	7/8	0	0	517⅓	1⅝	2¼	·686	Long fibre, but very coarse.
,, ,,	20	23	Thounggeen, very large dead tree.....	3	1¼	1	15	4	5/16	4/8	6/8	7/8	915¼	2⅜	¾	·696	Excellent, long and tenacious, broke very gradually.
,, ,,	24	24	Zemi Timber, best specimen.	3	1½	1	14	8	1/16	0	0	0	348⅓	1/16	¼	·680	Short carotty fibre.
Commissariat Specimens																	
1	25	Thounggeen Timber	3	1¼	2	1	0	5/16	5/16	0	0	630	7/16	0	0	Short bad fibre, broke across.	
2	26	Zemi Timber.....	3	1¼	2	3	8	6/8	0	0	0	404	1⅛	1		Short bad fibre, broke across.	
3	27	Zemi Timber.....	3	1¼	2	3	8	1/16	1⅛	0	0	460	1⅛	¼		Coarse rather long fibre, do. do.	
4	28	Zemi Timber.....	3	1¼	2	2	12	4/8	1 3/16	0	0	550	1¼	1/16		Short fibre, broke across.	
5	29	Thounggeen Timber..	3	1¼	2	1	0	5/16	5/16	0	0	570	5/8	1/16		Coarse fibre, full of Sap.	
6	30	Zemi Timber.....	3	1¼	2	1	0	7/16	5/16	0	0	575	5/8	1/16		Firm fibre, but rather short.	
7	31	Thounggeen.....	3	1¼	2	3	0	3/16	3/8	5/8	1 3/16	745½	0	3		Long fibre, broke very gradually.	
8	32	Padowk, seasoned.....	3	1¼	2	10	0	5/16	4/8	6/8	7/8	1085¼	1⅞	½	1·008	Firm hard fibre, great tenacity.	
9	33	Anan Timber.....	3	1¼	2	11	0	3/8	0	0	0	460½	0	1	·932	Fibre good and firm, specimen imperfect.	

These specimens are of Timber furnished for Arsenal purposes by the Commissariat Department.

(Signed) G. W. Y. SIMPSON, Captain,

Commanding Artillery Tenasserim Provinces.

Digitized by Google

MISCELLANEOUS.

Test of Qualification for direct Appointments to the Corps of Artillery, according to the Regulations of the Court of Directors of the East India Company, for their Military Seminary at Addiscombe.

The proficiency in Mathematical study will comprise at least the course laid down by Dr. Hutton, as far as the resistance of fluids inclusive, or the equivalent parts of the course, recently published by the Rev. J. Cape, Professor of Mathematics, &c. at Addiscombe, for the use of that institution.

"The above course, together with the whole course of Fortification, Artillery, Plates, Drawing, Military Drawing, and Surveying, is hereby declared to be the minimum of qualification for Artillery Service."

As the Cadets who are candidates for the same service at Addiscombe, pass eighteen months or two years at that institution, and know beforehand the precise nature of the qualifications and mode of examination, and also can ascertain what portions of the mathematical course are either not taught at all, or usually passed over, the following remarks have been drawn up for the information of the parents or guardians of the candidates for direct Artillery appointments to India.

First. In respect to Mathematics.—The qualifications to be determined by any of the old editions of Hutton's course, from the 1st to the 10th inclusive; but not by Dr. Olinthus Gregory's 11th edition, nor by Ramsay's, Rutherford's, or Davies's editions, all of which have been so far altered and new-modelled as to put the course into a very different form, from that which was contemplated by the regulations.

Supposing the candidate to obtain any of the old editions

Digitized by Google

of Hutton's course above mentioned, he may omit the following portions of the course, viz.

1. Cubic Equations.
2. Infinite series. Part second.
3. The whole of Land Surveying, the rules for which, as there given, have become obsolete.
4. The measurement of Artificers' work, excepting that duodecimal multiplication must be understood.
5. The Hyperbola in conic sections.
6. The equilibrium of arches.
7. Practical Gunnery.

Secondly. In respect to Fortification.—This is taught at Addiscombe, from a Treatise, published by Captain Straith, Professor of Fortification and Artillery. The present qualifications for the Artillery Cadets at Addiscombe are, a knowledge of the substance of Captain Straith's Treatise on Fortification, from the definitions, p. 1 to p. 396 inclusive, omitting the Appendix to chapter 9, and omitting also chapter 12.

The plates of fortification required correspond with those in the Atlas to Captain Straith's Treatise; but must all be drawn on a larger scale, and are as follows:

Plate 1, Figures 3 and 4. Plate 2, Figures 17, 14 and 18. (To be filled in and shaded.)

Plate 3, Fig. 28. Plate 4, Fig. 53. Plate 5, Fig. 54. (In outline only.)

Plate 6, Figs. 102, 117, 118. Plate 7, Figs. 124, 125. Plate 8, Figs. 134, 135. Plate 11, Figs. 1, 2, 3, 4, 5, 6, 7, 8. Plate 12, Figs. 14, 15, 16, 17, 18, 19. Plate 13, Figs. 26, 27, 28, 29. (To be filled in and shaded.)

Thirdly. In Artillery.—The qualification for the Artillery Cadets at Addiscombe, is a knowledge of the substance of Captain Straith's Memoirs on Artillery, from part 1 to 15 inclusive, omitting part 14; but the plates are not always drawn.

N. B. Qualifications both in Mathematics and in Fortification, equivalent to the above, will be satisfactory, no matter from what authors, or according to what system, the candidates may have studied. But in respect to fortification and Artillery particularly, considering that those branches are not taught in all parts of the kingdom, the public examiner has been instructed to make allowance for the difficulty of finding

Digitized by Google

competent masters, and therefore the candidates for direct Artillery appointments may be passed without possessing a knowledge of all the details contained in Captain Straith's Treatise before quoted; but they will be expected to understand the nature of works of Permanent Fortification, according to Vauban's first system, or the modern system, and to be able to explain the operations of a siege; and they must also have some knowledge of Field Fortification. They must produce Drawings of Fortification, and a plan of attack of a regular fortress, executed by them as students, which, if satisfactory, may be fewer in number than those required at Addiscombe. These plans must have been constructed according to scale, and not mere copies, as a proof of which, the candidates may be required to draw the outline of some work from dictation.

Under the same consideration, should the candidates be qualified in other respects, a very moderate knowledge of Artillery will be accepted, as they will have the opportunity of acquiring it in India.

Fourthly. Drawing and Surveying.—The Cadets at Addiscombe are taught Civil and Military Drawing, and are taught the practice of Surveying according to the rules contained in Major Basil Jackson's printed course of Military Surveying, which they follow in making Surveys of the country near Addiscombe.

The candidates for direct Artillery appointments will produce drawings in whatever style they may have been taught, whether landscape and figures, or topographical—the latter to include their actual surveys; and the common practice of land-surveying by the theodolite will be considered satisfactory.

As soon as any candidate who has obtained a nomination to a direct Artillery appointment shall be considered competent, his friends will send notice thereof to Mr. T. R. Clarke, at the East India House, by whom they will be informed as to the periods of examination appointed, when they will be re-

Digitized by Google

quired to appear before Colonel Pasley, at Chatham for that purpose, who will make a report of the qualifications of individual candidates, of whom several will be brought forward at the same time. Each examination will occupy several days, as is usual at the private examinations at Addiscombe, preliminary to the public examinations, when the appointments of the Cadets to the Artillery, &c. are decided. None will take place before the month of August next, and none later than the month of April, 1842.

Agreeably to the resolution of the Court of Directors of the 7th April, with a view to the protection of the Cadets studying at Addiscombe, the candidates for direct Artillery appointments who may pass satisfactory examinations before the 25th December, 1841, and who shall obtain certificates of approbation, from the public examiner to that effect, shall take rank below the Addiscombe Cadets who may be reported qualified for the Artillery at the public examination to be held in December, 1841, and all subsequently passed on such direct appointments shall take rank next below the Addiscombe Cadets who may be reported qualified for the Artillery in June, 1842.

Every candidate must produce a certificate of good conduct from the master under whom he last studied. No candidate can be appointed a direct Artillery Cadet who is under sixteen or above twenty-two years of age.

Memorandum published by Lieutenant Thomas Cook, R. N., F. R. S., Professor of Fortification at the Honorable East India Company's Military Seminary, Addiscombe, 3d July, 1845.

Having very long experienced the difficulty of conveying correct ideas on the subject of FORTIFICATION to youthful minds, whether by drawings or by theoretical instruction,—it occurred to me about six years ago, that if I could give the Cadets practical information by the use of a clean and cheap

Digitized by Google

material, that would admit of change of form, or constant repetition, without deterioration,—I should effect the object in a more attractive, and less laborious way, than that of constructing works of full dimensions, which, moreover, require much space, and more time than can be given here to the subject. With this view, some gabions, fascines, and sand-bags were prepared, on a scale of two inches to a foot, or one-sixth of the full size, for the purpose of modelling works in SAND, a little moistened with water. The result of the first experiments was so satisfactory, that at the next public examination at Addiscombe, a "double sap" thus made was produced; and after some Cadets were examined on the particulars of its construction, the Public Examiner ordered four others to demolish the sap, and in the presence of the Court, to construct a "two-gun battery" on the same scale, and with the same materials, which was done, and some brass model guns planted in battery, in the short space of *twenty-eight minutes*, to the most perfect satisfaction and gratification of all present, who were quite satisfied by ocular demonstration, that the Cadets were thoroughly acquainted with at least this branch of the subject. From that time to the present, we have carried on this system of teaching the art of Fortification (as an auxiliary to theory and plan drawing) with increasing energy, on scales varying from two inches, to a quarter of an inch to a foot. Vauban's, the Modern, Carnot's, Cœhorn's, Bousmard's, Choumara's, and Dufour's systems have been constructed, together with the usual field-works, and several Indian mud-forts. The attack against various places has been scientifically conducted, by a succession of parallels, raised and sunken batteries, zigzags, saps, &c. Mines have also been sprung to form practicable breaches. With this material we have thrown up hills, the heights of which have been regularly fortified. The difficult art of "defilading" works has been brought within the comprehension of the students. In some cases the hills have been scarped, to form defiles. Bridges have been formed across rivers, (the floor of the room having been coloured to

Digitized by Google

imitate water,) which enabled us to show bridge-heads, and the various defensive methods for strengthening the passages of rivers by abattis, trous de loup, &c. &c. In short almost everything may be done upon scale, for the purpose of giving instruction, by this simple, cheap, and efficacious plan. I could say very much of the distinguished approbation this system has met with, from very high authorities. It may however suffice to state, that it was ordered to be adopted at Woolwich Royal Military Academy by Lord Vivian, late Master General of the Ordnance,—by the Admiralty, for the instruction of the Marine Cadets at Portsmouth Naval College, —and that the Professor of Fortification at the Royal Military College at Sandhurst, was sent to Addiscombe a few weeks ago, expressly to make himself acquainted with the system, for adoption there. Several of the preparatory establishments for training youths for the Military Colleges, have also availed themselves of it. I will only add, that although this mode of instruction may be proceeded with out of doors, the Court of Directors of the Honorable East India Company, have manifested their approbation of the plan to such an extent, that they have lately erected a large building which cost upwards of £1,200, expressly for the purpose of carrying it out with the greatest advantage. Two or three men have been trained, to work with, and attend upon the Cadets when so employed, who also, usually, finish off the models when nearly completed.

Although a little practice would soon make the matter easy, it may be desirable that I should briefly state, the best way of proceeding in a case, in illustration of the subject generally. If, for example, an ELEVATED BATTERY, on a scale of two inches to a foot were required,—let the sand be spread on the floor of the building, to the depth of twelve inches, (equal to the depth of the ditch or six feet on the supposed scale) and let the surface of it be considered as representing the plane of site. Trace the outline of the face and epaulements, allowing two inches for every foot of the length of each. Place some pickets at the angles, and at the

Digitized by Google

extremities of the epaulements, sufficiently long to stand fifteen inches (7½ feet) above the surface of the sand: a cord running from one to the other at that height, will mark the line and height of the crest of the intended work. From those pickets at the angles, place others perpendicular to the face of the work, at distances equivalent to the different slopes, as far as the counterscarp of the ditch. The first of these pickets being sufficiently high to denote the foot of the superior slope, the second sufficiently low to denote the foot of the exterior slope; which in fact will be on the plane of site. Connect the three together by a cord at each end, and the profile of the intended parapet will thus be shown. If the corresponding pickets be united by cords, the foot of each slope will be defined. Proceed in a similar manner to trace the epaulements. Next place a row of "gabions" under the crest line (but one-fourth of the height of the crest *within* it) leaning them forward in such a direction, that when the interior slope is completed, it will just cut the line denoting the crest. Excavate between the pickets, which denote the breadth of the bottom of the ditch, down to the floor; throwing the sand up to fill the gabions, and to form the parapet. As the work proceeds, place a row of "fascines" on the gabions, excepting on those which are to form the sills of the embrasures: after this another row of gabions, and such as are to form the cheeks of the embrasures: then a finishing row of fascines: in short, on such a large scale, the construction may proceed almost the same, as if the work were of full dimensions. In like manner, if the intended work be two fronts of VAUBAN'S SYSTEM, on a scale of a quarter of an inch to a foot, the sand must be spread to a depth of 5½ inches (equal to the depth of the ditch or twenty-two feet) and rolled; the surface would, in this case also, represent the plane of site. Let the outline be traced, and pickets placed at the angles, and at the ends of the different faces of the works, from which must be laid off inwards, the slopes required: the elevation of the pickets to represent the relief of the different parts. Practically, the sand excavated from the ditches, will, as is usual in full size,

Digitized by Google

supply the quantity required to form the ramparts, parapets, &c.: but, excepting when making experiments to ascertain the exact proportion the "remblai" bears to the "deblai" of any work, it will be found more convenient to deviate from the course adopted in constructing a full-sized work. The implements used are trowels of different sizes, a few small spades, iron pickets, cord, measuring tapes, scales, and knee-caps made of leather, to buckle over the knees, to prevent injury to the Cadets, from occasionally kneeling upon the moistened sand.

In the first part of each term, the junior class is taken into the modelling hall, (in which about one hundred and fifty loads of sand have been deposited,) and employed in tracing out, and throwing up works of a simple nature; but previous to every half-yearly examination, more difficult works are constructed. At the present time there may be seen, the attack as carried on against two fronts of the modern system; —a bridge across a river protected by a tower, and fortified heights;—and a bridge in a mountain defile across a river, strengthened by a variety of engineering devices,—on a scale of a quarter of an inch to a foot. Two very strong casemated coast batteries,—and a fac simile of the Cabul-gate side of Ghuznee, with its turrets, &c., loopholed,—beautifully executed on a scale of half an inch to a foot. A raised battery, —a sunken battery,—and a double sap,—on a scale of two inches to a foot. Some of these have been standing for nearly two months.

Extracted from "Engines of War" published by Henry Wilkinson, A. R. A. S., LONDON, 1841.

SLINGS.

Pliny ascribes the invention of slings to the Phenecia but Vegetius attributes it to the inhabitants of the Baleric Islands (now called Majorca and Minorca) who were famous in Antiquity for using them. This weapon was principally used by the light armed Soldiers. Cyrus considered it unbecoming

Digitized by Google

an Officer; and Alexander, wishing to render his enemies as contemptible as possible to his own Soldiers, calls them "a "disorderly rabble designed for no other purpose than to cast "stones out of a sling." Arrows, stones, and leaden plummets, were thrown from them, some of which weighed no less than an Attic pound. The manner of slinging was by whirling it twice or thrice about the head before they discharged the bullet: thus Mezentius in Virgil, "Thrice round his head the loaded sling he whirled," but Vegetius commends those as the greatest artists, who cast it out with one turn about the head. Seneca reports, that its motion was so vehement, that the leaden plummets were frequently melted. The materials of which slings were composed were either flax, hair, or leather, woven into bands, or cut into thongs, broad in the centre to receive the load, and tapering off to the extremities; they were sometimes attached to sticks to increase their power, and the Greeks as well as Romans, projected darts and javelins by the assistance of a sling or strap girt round their middle. D'Aubigne records the fact, that slings were used at the siege of Sancerre in 1572 by the Huguenots in order to save their powder; and hence, he says they were called "Sancerre harquebusses." This is probably the last instance of their use in European warfare; although it is stated by Sir Robert Wilson, that at the battle of Alexandria, the French and English threw stones at each other during a temporary want of ammunition, with such effect that a Serjeant of the 28th Regiment was killed, and several of the men were wounded.

ORIGIN OF FIRE ARMS.

Although there may be some doubt as to the precise meaning of the terms employed, it is generally supposed by writers on this subject that by "crakys of war" mentioned by John Barber, Archdeacon of Aberdeen, in his metrical life of Robert Bruce, cannon of some description were implied. He states that they were used by Edward III. in his first Campaign against the Scots in 1327. This is the earliest in-

Digitized by Google

stance recorded and it is certain that about this period they were first employed in warfare, gunpowder having been proposed for the destruction of armies many years previous. Vilam and Rapin say, that the English first made use of cannon in France at the battle of Cressey (1346) before which they were unknown in that country. Rapin observes that " four pieces " which they had placed on a hill, did so much execution " amongst the French Troops, and inspired them with so " much terror, that part of the success of the day has been " attributed to the surprise occasioned by this novelty." Father Daniel, however says, the French used them in 1338; and gunpowder is stated to have been used at the siege of Algiers in 1342. The moral effect produced by the early fire arms was probably much greater than their destructive powers. In 1378 when the English unsuccessfully besieged St. Malo, 400 cannon are said to have been employed; but these are supposed to have been of the smaller kind, called hand-cannon or culverins, which were carried by two men, and fired from a kind of tripod, or rest, fixed in the ground. Bolts and quarrels were shot from cannon in the reign of Henry V. (1413): these were succeeded by stones, as in 1418. Henry ordered the clerk of the works of his ordnance to procure labourers for the making of 7000 stones for the guns of different sorts, in the Quarries of Maidstone in Kent.

MATERIALS OF WHICH CANNONS HAVE BEEN COMPOSED.

The materials of which cannon have been composed are various; besides metals—wood, leather, rope, and even water, in the form of ice, have been employed in their construction. In the Arsenal at Venice there is a mortar made of a coil of rope, covered with raw hides, intended to throw a stone bullet; and, in 1740, several cannon were cut out of solid ice at St. Petersburgh, and fired repeatedly with ice bullets without bursting. A variety of early and recent specimens of curious Artillery may be seen in the Arsenal and in the Rotunda at Woolwich.

Digitized by Google

PISTOLS.

Pistols derived their origin from Pistoia, a city of Etruria, where they were manufactured previous to 1544, in the reign of Frances I.; in which year the German horsemen, called *reiters* are said to have used them in France before the French, and in the time of Henry II.; those who carried them were called *pistoliers*. These pistols were the arquebuse in miniature, the barrels being one foot in length, and fired by the wheel-lock; they were introduced into England about the middle of the sixteenth century.

CUMBROUSNESS OF ARMOUR.

Monsieur de la Noue says, that the ancient Knights loaded themselves with anvils instead of armour, and that it was so closely fitted and sometimes screwed so firmly on, that it was almost impossible to kill them when unhorsed, although they were perfectly defenceless, as the *misericorde* or dagger, provided for such purposes, could not penetrate the joints. Philip de Comines has recorded, that at the battle of Fournoue under Charles VIII. a number of Italian Knights, who were overthrown and unable to rise on account of the weight of their armour, could not be killed until they were broken up like huge lobsters, with wood cutters' axes, by the servants and followers of the army, which fully justified the observation of James I. who, speaking in praise of armour said, "that it not only protected the wearer, but prevented him "from doing any injury to others." In fact, we find in several battles about the time referred to, that not a single Knight was slain. An anecdote in point is also related of George IV.; after the Battle of Waterloo, it was proposed to make some change in the dress of the Life Guards; the King ordered one of the Soldiers to be sent for, who had greatly distinguished himself, and was said to have slain six or seven French Cuirassiers in single combat. He was asked a variety of questions, to each of which he assented, until the King, perceiving that his opinion was biassed by the presence of

Digitized by Google

royalty and his own Officers, said to him, " well, if you were " going to have such another day's work as you had at " Waterloo, how would you like to be dressed?" " Please " your Majesty," he replied, " in that case, I had rather be " in my shirt sleeves;" thus demonstrating the folly of loading Soldiers with useless defensive clothing, which only impedes the free exercise of their muscular powers.

ORIGIN OF THE BAYONET.

The idea of affixing a dagger to the end of the Musket appears to have occurred to different Officers, who occasionally put it in practice in order to convert the Musket into a pike when the Soldiers had exhausted their ammunition. The first bayonets were consequently merely daggers, the handles of which fitted in to the muzzles of the barrels. Father Daniel says, they were regularly introduced into France about 1671; the first corps armed with them was the Regiment of Fusiliers raised in that year; and they derive their name from having been originally manufactured at Bayaune. The present method of fastening them to the muzzle of the musket was also a French invention, first used by Marshal Catinat in 1693, at the battle of Marsaglia; the slaughter was immense, and the rout of the allies complete. Similar success attended Marshal Tallard at the battle of Spires in 1703, and the Duc de Vendome in 1705 at Calcinata in Italy; but it was not until two great victories had been obtained by them, that they were adopted by other nations. Many other battles were almost exclusively gained by the use of them, and the Spaniards were uniformly defeated by the Bayonet alone, in all their contests with the French at the close of the Campaign in 1794. The English Grenadiers first employed them in the short reign of James II. Bayonets however underwent several mutations before the socket Bayonet was adopted; two rings were fixed to the handle to receive the muzzle, and in the reign of Queen Anne, two Horse Grenadiers rode before her Carriage with Bayonets fixed in this manner. The gene-

Digitized by Google

ral introduction of the Bayonet superseded the use of the pike, which was abolished in France by Royal Ordinance in 1703, with the advice of Marshal de Vauban; and pikes were probably laid aside in England about the same time, as in 1690 a book of the pike exercise was published by Royal Command, and in 1705 the Gentleman's Dictionary describes it as a weapon formerly in use, but then changed for the musket.

PERCUSSION CAP.

The late Mr. Joseph Egg and several other persons lay claim to it. Mr. Egg it is supposed purchased it from Mr. Roantree, a Gun maker at Barnard Castle Durham, who had it from a workman employed by Mr. Joshua Shaw, now residing it is believed at Philadelphia. Mr. Shaw is said to have stated that in 1814 he invented a steel cap, which, when fired, was retained to be primed again; that in 1815 he made a pewter cap, which was thrown away after using; and lastly, that in 1816 he used a copper cap precisely similar to those at present employed. He made application for a patent in England, but the solicitor to whom it was referred decided, that it could not be obtained without infringing Forsyth's patent, then in force. Baron Heurtloup has patented a very novel and ingenious method of firing Guns by percussion, which has never yet come into use from a variety of causes, and it is probable that it may never be adopted; but it deserves notice, as being quite original. He has named it the *koptipter* from its peculiar action of *cutting and striking*, it is dependent on the fact, that when fulminating powder is enclosed in a tube of soft metal, it may be cut through by a sharp edged instrument without explosion although when struck with a blunter edge it will ignite. On this principle the Baron has contrived a long and very thin tube of soft metal filled with fulminating powder, which is enclosed in the stock, and gradually advanced by the action of the lock, which causes a small portion of the tube to pro-

Digitized by Google

trude just over the touch-hole: the cock in falling first cuts off this projecting portion with a sharp edge, and instantly strikes the piece thus detached with a lower blunt elevation on its striking surface, which explodes it simultaneously with the first operation. The simplicity of the copper cap, however, almost precludes the adoption of any complicated plan, although ingenious. The most simple mechanical arrangement for firing by percussion is the lock invented by Mr. Wilkinson, and patented in 1839; it consists of only five principal parts, including the guard, trigger-plate, and trigger; it fires on the under side by means of a copper cap and has the shortest and most direct communication into the barrel that is possible, being in a right line: the stock is much stronger, and the cost considerably less than any other plan. Two muskets fitted with these locks were sent to Woolwich by order of the Master General of the Ordnance in July, 1840, and fired 2000 times with ball cartridges, without a single failure or any mishap whatever. Sometimes 100 rounds a day were fired without cleaning; after which they were tried against time, and were fired equally quick with the new percussion muskets. The Emperor of Russia honored Mr. Wilkinson with a splendid diamond ring as a mark of his Imperial Majesty's approbation of this invention, and referred the musket sent, to the Minister of War.

QUANTITIES OF GUNPOWDER EMPLOYED IN VARIOUS SIEGES.

At the siege of Cuidad Rodrigo in January, 1812, 74,978 lb. of Gunpowder were consumed in 30½ hours; at the storming of Badajoz in March of the same year, 228,830 lb. in 104 hours, and this was from the great Guns only; at the first and second siege of San Sebastian 502,110 lb.; and at the siege of Taragoza, the French exploded 45,000lb. of powder in the mines, and threw 16,000 shells during the bombardment. To which may be added that some of our private manufacturers make from 8,000 to 10,000 barrels of powder

Digitized by Google

a year in time of peace, and from 10,000 to 14,000 barrels during war. The quantity of powder received and proved at the Royal Magazines from Faversham, and the several powder makers contracting with Government, amounted during the seven years from 1776 to 1782 inclusive, to 244,349 barrels of 100lb. each, being equal, on an average to 3,490,700lb. annually. The quantity of powder in store at the different Magazines in Great Britain, Guernsey, Jersey, and the Isle of Man in 1783, was about 80,000 barrels.

DAMASCUS SWORDS.

It is well known that Damascus was formerly celebrated all over the world for its manufacture of sword blades; and it is recorded, that when Timur Sung conquered Syria, in the beginning of the fourteenth century, he carried off all the manufacturers of steel into Persia; since which period the fabrication of Arms has declined at Damascus, and the successors of those workmen, being dispersed over the East, are said either to have lost the secret, or ceased to make blades of more than ordinary goodness. We must however, first divest ourselves of all prejudice in favor of the exaggerated reports of their qualities, and remember that, at the time when the natives of the East were well acquainted with the art of working in Iron and Steel, we, and indeed all Europe, appear to have been comparatively in a state of perfect ignorance; the ancient swords of Damascus, therefore, when opposed to those of other countries, were probably found to be infinitely superior in temper and quality; which, combined with their great external beauty, stamped them for ages with so high a character for excellence, that they are even now handed down as heir-looms by Eastern princes to their posterity. The extraordinary prices* that have been offered

* Two swords presented to Sir John Campbell by the Shah of Persia, were valued at 200 ducats each, or about £86. And the Umeer of Scinde had a large sword, for which he refused 9000 Rupees, equal to £900. Sir George Ousely, Bart. has several swords, some of which were valued even at a higher rate.

Digitized by Google

and obtained for them, sufficiently attest the estimation in which they were held, which is certainly not warranted in the present day, when swords of equal or superior quality might be manufactured at one-twentieth the expense. In addition to the foregoing observations, the strength and great dexterity of the swordsman must be taken into consideration, and much of the apparent superiority of these blades may be undoubtedly ascribed to this cause.

Digitized by Google

SIGNS OF INCREASE, MATURITY, AND DECAY IN TREES.

The qualities of wood depend much on the state of the tree when cut down. It appears, from the experiments of M. Hartig, upon wood applied as fuel, that trees which have attained maturity without passing into decay, are the best for the production of heat. Thus the value of an elm of one hundred years is to that of one of thirty years, as twelve is to nine; that of an ash of one hundred years to one of thirty years, as fifteen to eleven. When the trees begin to decay, their value rapidly diminishes; thus, if an oak of two hundred years yields wood worth 15 shillings per cord, a tree of the same kind passing to decay yields wood only worth 12 shillings. When the wood is used for other purposes, the advantages conferred by a mature and healthy state are more considerable.

The common elm, growing in a forest and in good earth acquires its full increase in about one hundred and fifty years, but it will live many ages, even five or six hundred years. Large forest elms are cut down with advantage when of an age between one hundred and one hundred and thirty years, and then furnish a large quantity of building wood. The duration of the life of an elm depends much upon the soil; in a dry soil it becomes aged, as it were, in forty, fifty or sixty years. Elms which have been lopped, live for a shorter period than the others. Those which grow by the road side, or in thin plantations, may be cut when seventy or eighty years of age. In general, the increase of hard woods, as the oak and the elm, is small at first; it successively augments until the twentieth or twenty-fifth year, is then uniform until the age of sixty to eighty years, after which it sensibly diminishes. For these and other reasons, it is important that trees should be cut down when they are at their mature state, and not simply when they undergo no further increase. When the period has arrived after which the increase of the tree would be less and less from year to year, then the tree should

Digitized by Google

be felled, for no advantage accrues from its remaining longer in the ground. The indications of the mature state of a tree are by no means so evident as those of decay, but still certain signs of these states, as well as of the vigorous condition of the tree, may always be observed.

1. *Signs announcing the vigour of a Tree.*—The branches, especially towards the top, are vigorous; the annual shoots strong and long; the leaves green, vigorous, and thick principally at the summit, and falling late in autumn; the bark is clear, fine, united, and nearly of the same colour from the foot to the large branches. If at the bottom of the veins, or divisions, of the thick bark, there appear smaller divisions which follow from below, upwards, in the direction of the fibres, and live bark be observed at the bottom of these divisions, it is an indication that the tree is very vigorous and rapidly increasing in size. If some of the lower branches, stifled by the others, are yellow, languishing, and even dead, this is an accidental effect, and is no proof of the languor of the tree. Finally it is a sign of vigour when branches are seen at the summit of the tree, rising above and being much longer than the others; but it is to be observed that all trees with round heads do not throw out branches with equal force.

2. *Signs that indicate that the Tree is mature.*—Generally the head of the tree is rounded; the shoots, diminish in length each year, and the furthest shoots add to the length of the branches only by the length of the bud; the leaves are put forth early in spring and become yellow in autumn before those of vigorous trees, and at this time the lower leaves are greener than the upper. The branches incline towards the horizon, and form angles sometimes of sixty or seventy degrees. These apparent signs, and the thinness of the layer deposited by the sap, indicate that the tree makes but small additions to itself, and now it should be cut down. The nature of the earth should be examined, as well also as the kind of tree, to form a judgment whether the tree should be left to increase still further, or whether it will be more proper

Digitized by Google

to fell it. An exact age cannot be assigned for each species, but it has been observed, that an elm situated in an insulated plantation may be felled with advantage when between seventy and eighty years of age.

3. *Signs of decay in a Tree.*—When a tree becomes crowned, *i. e.* when the upper branches die, it infallibly indicates especially for isolated trees, that the central wood is undergoing alteration, and the tree passing to decay. When the bark separates from the wood, or when it is divided by separations which pass across it, the tree is in a considerable state of degradation. When the bark is loaded with moss, lichen, or fungi, or is marked with black or red spots, these signs of alteration in the bark justify suspicions of alteration in the wood within. When sap is seen to flow from clefts in the bark, it is a sign that the tree will soon die. As to wounds or gutterings, these defects may arise from local causes, and are not necessarily the result of old age.

ON THE PRESERVATION OF WOOD.

A paper bearing this title was lately read before the French Academy of Sciences, by its author, Dr. Boucherie, and we insert it because the subject has lately attracted considerable attention, and considering the extensive employment of wood for paving, every thing relative to the subject is important.

He contrasts the increasing consumption and the rapid decay of timber, with its slow rate of production, which make it necessary to economize its employment. He adverts to the many projects for its preservation, enumerated first by Mr. John Knowles, and the methods subsequently proposed, to many of which he objects from their uselessness; to others from the slow and superficial manner in which timbers part with their contained fluids, or absorb new ones by simple immersion, (circumstances long since proved by Duhamel;) and to all from their expense, the ultimate test of general application.

Digitized by Google

Dr. Boucherie argues, that all the changes in woods are attributable to the soluble parts they contain which either give rise to fermentation or decay, or serve as food for the worms that so rapidly penetrate even the hardest woods. As the results of analysis he says, that sound timbers contain from three to seven per cent. of soluble matters, and the decayed and worm-eaten rarely two, commonly less than one per cent.; he therefore concludes that "since the soluble matters of the wood were the causes of the changes it undergoes, it is necessary to its preservation, either to abstract the soluble parts in any way, or to render them insoluble by introducing substances which should render infermentable or inalimentary; which he considers may be done by many of the metallic salts and earthy chlorides.

Dr. Boucherie shows by parallel experiments upon "vegetable matters very susceptible of decomposition, as flour, the pulps of carrot and beet root, the melon, &c. which only differ from wood, of which they possess the origin and constitution, by the greater proportion of soluble matter which they contain) that in the natural states they rapidly alter, but are preserved by the pyrolignite of iron a cheaper material than the corrosive sublimate commonly used, and one very desirable in several respects. He presumed that by immersing the end of a tree immediately after it was felled into a liquid the vital energies not having ceased, the wood then absorbs such fluid through all its pores, by a process which he calls aspiration; and in this fortunate surmise he was entirely successful. This led step by step to numerous practical results, which their inventor enumerates as follows and describes in separate chapters.

1st. "For protecting the woods from the dry or wet rot."

2d. "For augmenting their hardness."

3d. "For preserving and developing their flexibility and their elasticity."

4th. "For rendering impossible the splits (disjunctions)

Digitized by Google

which take place when they are brought into use or are submitted to atmospheric changes."

5th. "For greatly reducing their inflammability and combustibility."

6th. We shall endeavour to convey a general notion of the methods in the same order.

1. *Durability.*—He took a poplar-tree measuring 28 metres in height and 40 centimetres diameter simply divided from its root with its branches and leaves undisturbed, and immersed it erect to the depth of 20 centimetres in a vessel containing pyrolignite of iron; in six days it was entirely impregnated even to the leaves, and had absorbed the large quantity of three hectotitres. This method required powerful lifting apparatus, and a support for the tree to lean against and was therefore objectionable. He repeatedly operated upon trees lying on the ground, by attaching to their bases waterproof bags containing the liquid, the experiments were varied in many ways; sometimes portions of the branches were lopped off but the crown or tuft was always left upon the principal stem; at other times the aspiration was effected by boring detached holes near the earth supplied with different fluids, which gave rise to all kinds of diversities; and other trees were pierced entirely through, and a horizontal cut extending to within an inch or so of each side was made with a thick saw, leaving only sufficient wood for the support of the trees.

For fear of losing the trees upon which he had the opportunity of experimenting, the process was not deferred beyond 24, 36, or 48 hours after they were felled, as the vigour of the absorption was found to abate rapidly after the first day, and that at about the tenth day it was scarcely perceptible; it was also found the aspiration entirely failed in dead wood, whether occurring at the heart of old trees or at parts of others from any accidental interruption of the flow of the sap during the growth; and also that resinous trees absorbed the fluids less rapidly than others. Observations were also made of the quantities of the liquids taken up; these when of a neutral

Digitized by Google

kind, as the chloride of soda often equalled in bulk that of the wood itself without causing any addition to its weight; the acid and alkaline fluids were less abundantly absorbed, apparently from contracting the vessels by their astringent action. It is stated that the pyrolignite of iron effected the preservation of the substance when equal to less than a fiftieth of the weight of the green wood. These points are all separately treated in the original paper.

2d. The hardness of the wood was considered by various workmen to be more than doubled by the action of the pyrolignite.

3d. The flexibility (due to a certain presence of moisture) was increased in a remarkable manner by the chloride of lime and other deliquescent salts, the degree of elasticity depending upon their greater or less concentration. As a cheap substitute for the above the stagnant water of salt marshes was adopted, with a fifth of the pyrolignite, for the greater certainty of preservation. Pieces of prepared deal, 3 millimetres thick and 60 centimetres long, were capable of being twisted and bent in all directions, as into screws also into three circular coils; the wood immediately regained its figure when released; this condition lasted eighteen months, that is until the time his paper was read.

4th. The warping and splitting, principally due to the continual effect of the atmosphere in abstracting and restoring the moisture, was stayed by impregnating the wood with a weak infusion of the chloride, so as always to retain it to a certain degree moist; one-fifth of pyrolignite was also added in this case. The seasoning of the wood was also considered to be expedited by the process, and which was not found to interfere with the ordinary use of oil-paint, &c. Large boards of the prepared wood, some of which were painted on one or both sides, and similar boards of unprepared wood were compared; at the end of twelve months, the former were perfect as to form, the latter were warped and twisted as usual.

5th. The inflammability and combustibility of the woods

Digitized by Google

were also prevented by the earthy chlorides, which fuse on their surfaces by the application of heat and render them difficult of ignition. Two similar cabins were built of prepared and of ordinary wood respectively, and similar fires were lighted in each; the latter was entirely burned, the other was barely blackened.

6th. In respect to colors infused by the aspiratory process, the vegetable colors were found to answer less perfectly than the mineral, and the latter succeeded best when the color was introduced at two processes, so that the chemical change, (that of ordinary dyeing) occurred in the pores of the wood itself. Odorous matters, required to be infused in weak alcoholic solutions, or essential oils they were considered to be equally durable with those supplied by the hand of nature; and resins similarly introduced were found to increase amazingly the inflammability of the woods, and to render them impervious to water.

In a word the method promises the means of working almost any desired change in the constitution and properties of woods, when the fields are presented to them before the vitality of the tree has ceased. It is true we have as yet only two years' trial of these experiments, but they have been scientifically deduced, and their inventor is still engaged in prosecuting them. It is to be hoped, and also expected, that these interesting and flattering promises of success will be realized, and even extended, when tried by that most severe of all tests, time.

CAUSES OF THE DECAY OF WOOD.

It appears that the contact of water and air are the chief causes of the decay of wood. If therefore, any means can be devised, by which the access of moisture and air can be prevented, the wood is secure against decay. This principle may be illustrated by supposing a cylinder of dry wood to be placed in a glass tube or case, which it exactly fills, and the two ends of which are, as it is called, hermetically sealed,

Digitized by Google

or entirely closed. Who will doubt that such a piece of wood might remain in the open air a thousand years unchanged? Or let us take a still more opposite illustration of this fact —that of amber, a native bitumen, or resin, in which a variety of small flies, filaments of vegetables, and others of the most fragile substances, are seen embedded, having been preserved from decay much longer, probably, than a thousand years, and with no apparent tendency to change for ten times that period.

To exclude air and moisture, various experiments have been employed, of which the most common is covering the surface with paint; which is oil mixed with some substance capable of giving it the color which we desire. It is well known that several of the oils, as those of linseed, hemp-seed, &c., become dry when thinly spread on any hard substance. The drying quality is much assisted by being previously boiled with certain metallic oxides, more especially that of lead, or litharge. The crust so formed is with difficulty penetrated by moisture or air. For this purpose, also, drying oil is spread on silk or linen, in the manufacture of umbrellas, &c.

When paint is employed within doors, it is customary to add to the oil, besides the coloring matter, some essential oil of turpentine, which not only makes it dry more readily, but, giving it greater tenuity, causes it to flow more freely from the brush, and therefore to go farther in the work. For the same purpose it forms a part of the paint used on wood and iron work in the open air, but most improperly; for on rubbing wood painted white, and long exposed to the weather, the white lead comes off in a dry powder like whiting; as if the vehicle which glued it to the wood had been decomposed and lost, leaving only the pigment behind.

The composition, which experience has proved to be the best adapted for the preservation of wood from both species of decay, (viz. the wet and dry rot) is as follows:—Melt twelve ounces of rosin in an iron pot or kettle; when melted, add eight ounces of roll brimstone, and just when both are in a liquid state, pour in three gallons of train, or whale oil. Heat the

Digitized by Google

whole slowly, gradually adding four ounces of bees' wax cut into small bits, frequently stir the mixture, and as soon as the solid ingredients are dissolved, add as much Spanish brown, or red or yellow ochre color, (first ground fine with some of the oil,) as will give the whole a deep shade. It will now be fit for use. Lay on this paint or varnish as hot and thin as possible; and some days after the first coat becomes dry, give a second. These coats will preserve planks, &c., for ages. What remains unused will become solid on cooling, and may be re-melted for future occasions. Dr. Parry used some of this composition on elm paling, which eighteen years after, was as sound as when first put up.

All the substances contained in this mixture are capable of perfect incorporation with each other by heat, and when separately exposed, are with great difficulty acted on by water or air in any heat which occurs in our climate. They should be applied hot with a common painters' brush on the wood which is previously very dry, so as to sink deeply into its pores; and though at first they are apparently somewhat greasy when cold, yet after some days they make a firm varnish, which does not come off on rubbing. When it is required to give beauty to the work, coloring matters may either be added to the mixture, or afterwards applied over it in form of common paint. Two coats of the composition should always be given; and in all compound machinery, the separate parts should be so varnished before they are put together; after which it will be prudent to give a third coating to the joints, or to any other part which is peculiarly exposed to the action of moisture, such as water-shoots, flood-gates, the beds of carts, the tops of posts and rails, and all timber which is near or within the ground. Each coat should be dry before the parts are joined, or the last coat applied.

This composition will also prevent iron and other metals from rusting.

It is necessary to mention, that compositions made of hot oil should, for the sake of security, be heated in metallic

Digitized by Google

or glazed earthen vessels, in the open air. For whenever oil is brought to the boiling point, or 612 degrees of Fahrenheit's thermometer, the vapour immediately catches fire, although not in contact with any flame: now though a lower degree of temperature than that of boiling should be used in this process, it is not always practicable either exactly to regulate the heat, or to prevent the overflowing of the materials; in either of these cases were the melting performed in a house, the most fatal accidents might follow.

Preservation of Wood by Charcoal.—The following mode of preventing rottenness in pales, water-shoots, &c., is also recommended by Dr. Parry, who says:—

"More than thirty years ago this subject presented itself to my mind, on seeing some water-shoots, which had been pitched and painted in the common way, taken down in a state of complete rottenness. I had read that charcoal buried in the moist earth, had come down to us perfectly sound from the times of the Romans; and that posts long withstood the same moisture, if the part intended to be put into the ground was charred all round to a certain depth. Impressed with this fact, I determined to try an artificial coating of charcoal, and when new water-shoots were constructed, I strongly and carefully rubbed them with a coat of drying oil, which I immediately dredged all over with a thick layer of charcoal finely powdered, and contained in a muslin bag. After two or three days, when the oil was thoroughly dried, and firmly retained the greatest part of the charcoal, I brushed off what was loose, and over that which adhered, I applied a coat of common lead-colored paint, and a few days after, a second. The whole became a firm and solid crust; after which the shoots were put in their places, and being examined many years afterward, appeared perfectly sound. Any other color would probably have succeeded equally well with that which I employed. I do not think that lamp black, which is a pure species of charcoal, would have answered the purpose of forming a thick defensive covering so well as the grosser

Digitized by Google

charcoal which I used. But whatever sort of charcoal is employed, it ought either to be fresh made or heated again in close vessels, so as to expel the water which it greedily attracts from the air. It is to be observed here, that the practice of pitching pales, &c., is both incommodious and inefficacious, as pitch is so liable to be melted by the heat of the sun."

ON SEASONING TIMBER.

The premature decay of timber, and especially of the oak, by what is technically called the dry rot, is a subject which has occupied no small share of public attention. If we may credit all that we read and hear, the immersing of timber in Kyan's mercurial preparation is the nearest approximation to the long wished for desideratum. Still I cannot conceal my doubts as to its general utility. Its application to timber for lighter purposes may be of much use in promoting durability; but its action on the huge timbers of even a third rate man-of-war will, I fear, come infinitely short of expectation; and, indeed I think it highly probable that after experience will prove that, from the claims of a decided specific, Kyan's process must degenerate to the rank of an expensive auxiliary.

In all our attempts to arrest the progress of dry rot, there seems to be an obvious misdirection of inquiry; our investigations not having been yet directed to the more immediate cause of the malady. In organic bodies preventives are always preferable to cures; therefore, wherever detrimental effects present themselves, we ought at once to turn our attention to the producing cause with a view to its removal, rather than to the application of temporary palliatives. That the appearance of precocious decay in manufactured timber may be traced to the presence of alburnous matter, in its fluid state, in the sap vessels, is a fact generally admitted. When an oak tree with its vegetative powers in full operation is felled, the sap, or alburnous fluid, not having been perfected, or converted by the process of foliaceous elaboration to

Digitized by Google

its ultimate purpose, becomes stagnant; putrefaction speedily commences, and in a short time communicates with and contaminates, the sounder parts of the fibrous column. The direct means employed by nature in decomposing vegetable matter does not appear to have received its due share of consideration from the naturalist. The agency of alburnous matter in an imperfect state is allowed; but, judging from the analogy that subsists between animal and vegetable creation, we can only view this as a secondary cause. In all bodies, whether animal or vegetable, where vitality has ceased to exist, it seems to be a universal law of nature, in the process of decomposition, to employ some active foreign power. Self-destruction forms no clause in the natural code; therefore we may rest assured that there is something else in operation, than merely the presence of simple alburnous fluid. Animal bodies contain the seeds of corruption within themselves; the different fluids teem with countless millions of animated beings. When the vital functions are brought to a close, these tiny tenants of the veins and arteries commence the work of devastation upon the more assailable matter: the putrid mass engenders animals of larger dimensions, to gnaw the sounder portions of the frame, and shortly afterwards the loathsome task of uniting earth to earth is accomplished.

It is possible that the decomposition of vegetable substances is performed by means not very dissimilar to that of animals. The germs of the dry rot may be communicated to the fibrous mass through the medium of the secretive organs at the root. Doubtless, the alburnous fluid is tenanted by legions of animalcules, the putrid remains of which in the sap vessels may form a soil or bed, for the development of the embryo fungus. Immersion in corrosive sublimate imparts no additional strength to the woody fibre, it only destroys the vitality of the matter in which the dry rot originates; and, if the foregoing remarks on the origin of the malady are based in truth, then we have within our reach agents equally, or even more, effective, and far less expensive, than corrosive subli-

Digitized by Google

mate. If it can be clearly proved, that unconverted sap in timber is the source of the dry rot, as already suggested, then I have succeeded recently in the inventing of a process, whereby the sap can be completely extracted from logs of almost any size. By this process (the material for the preparing of which can be had for picking up any where) I find that oak timber can be divested of the sap, and so seasoned, that, in less than ten hours after being cut, it may be put into the hands of the carpenter. It was my intention to apply this process to preventing the shrinking and twisting of larch timber; but I have not had an opportunity as yet of making the experiment: from what I have seen of its effects on oak, however I entertain the most sanguine hopes of success.

An aptitude to act on superficial evidence is a fault common to our nature; and hence we are too often led to mistake effect for cause. Precocious decay, or dry rot, is an effect, in my opinion, produced in most instances by the very questionable manner in which oak timber is harvested. In felling most of the other species of hard-wood trees, it is an invariable practice to have them cut down when vegetation is in its most inert state; but, from the great value of its bark, the oak forms an exception to this most judicious rule. The process of disbarking can only be performed when vegetation is in full activity, and certainly it requires no argument to show that this, of all seasons in the year, is the most improper to fell timber of any sort, if durability is to be taken into consideration.

All timber then, for the use of the British Navy ought to be purchased growing, with an understanding between the contracting parties, that the vender shall be bound to fell the trees at such seasons as may be agreed upon; namely, in the months of December or January. Had some such plan as this been adopted long ago by the Officers of the public dockyards, it is my firm belief that dry rot would have been much less prevalent. Even the process of felling herein recommended is susceptible of improvement. Where any large oak-tree

Digitized by Google

fit for naval purposes is sold, it might be arranged that the purchaser should be allowed two, three or more years to remove it. In this interim vegetation might be gradually retarded, by severing from the main root, annually, so many of the principal lateral roots until the foliage all but refused to expand. Under this treatment the usual copious flow of sap would be diminished; and, by reducing the medium of its ascent annually, the fibre would become seasoned, and would acquire a rigidity and toughness not obtainable under the old regimen.

Castle Ashby. J. Muro.

ANTI-DRY ROT.

The dry rot is a plant called by botanists merulius lachrymans, which is, alas, too common on the inside of wainscottings, where there is not a free circulation of air, in the hollow trunks of trees, beams, ship timber, &c. It first appears like a soft, very light, cottony mass, of a white color; afterwards it throws out yellow or orange colored veins, which at last become reddish brown, and distil as it were drops of water, filled with minute ferruginous sporules or seeds, which, by the liquid, are conveyed to other parts of the trunk; and thus the dreadful contagion is propagated far and wide and the original timber broken up into perfect dust, its destruction being occasioned not merely by the growth of the plant itself, but accelerated by the moisture thus introduced.

The principle upon which all anti-dry rot preparations must be formed is that vegetable life should be destroyed, and yet that the woody fibre should not be injured—and to fulfil both these conditions nothing but a solution of corrosive sublimate is found to answer, and this in proportion to the degree of perfection with which the various bodies are saturated by the drug; and would be under certain circumstances, sufficient, but it has yet to be proved how far it may be efficacious for large beams of timber, as this must depend upon the fact of penetration.

Digitized by Google

The following remarks are extracted from the evidence taken before the Commissioners appointed to examine into the efficacy of Mr. Kyan's process.

"All the persons examined who have used the prepared wood are of opinion that the process renders the ordinary length of time for seasoning timber unnecessary. Sir Robert Smirke, however, thinks that while timber of large scantling may be used the sooner for it, still it would not supersede the usual length of time for seasoning wood for joiners work."

As to the strength of the solution, with a view to the expense, there has been great inconsistency in the statements made to the Commissioners. The solution for the experiment at Somerset House, consisted of 224 pounds corrosive sublimate to 1,062 gallons of water being rather more than 1 pound of corrosive sublimate to 5 gallons of water, (the proportion last named by Mr. Kyan) the price of the corrosive sublimate at the time of this experiment being *3s. 7d.* per pound. It was stated by Mr. Kyan that the solution loses none of its strength, and becomes in no way altered by the immersion of the timber; and the greater part of the solution in the tank, at the time of the Commissioners' visit to Mr. Kyan's premises, was stated to have been in use some years.

Two bottles of the solution used for the experiments at Somerset House were sent to Professor Faraday, one having been filled before the immersion of the timber, and the other afterwards; and he has stated that they contain the same proportion of corrosive sublimate in solution.

On the point of expense, it may be proper to observe that the additional cost of building the *Samuel Enderbey*, a ship 420 tons, of entirely prepared timber was £240; and it appears the Board of Admiralty have agreed to pay at the rate of 15*s.* a load extra for such as may be used in the construction of the *Linnet*.

"As to the salubrity of the process, the evidence proves it to have produced no ill effect upon the health of the workmen, who have used the prepared timber for ship building or other

Digitized by Google

purposes. It, however, appears that great caution is requisite in preparing the solution, and in the use of the process.

"With regard to its effects on the health of ships' crews, the Commissioners observe that the *Samuel Enderbey*, which was completely built with prepared timber last year, sailed last October for the South Seas; and in three accounts received from apprentices on board her (none others have come to hand) one of which was dated Lat. 3° S., Long. 24° 30 W., the crew was mentioned as being all well. Another Ship the *John Palmer*, extensively repaired in the autumn of 1833 with new timbers and new topsides from the light water mark; the interior was also new from the lower deck upwards; and the whole of the timber used for these works as also the plank used for the men's sleeping berths, were prepared on Mr. Kyan's plan. Two accounts received from the Master since she sailed, one dated on the Line, and the other from Straits of Timor, state that the crew were all well.

"The Commissioners consider it desirable to avoid any risk, by placing provisions in direct contact with the prepared wood; and they suggest that ropes and sails being much handled by seamen, the raw material of them when prepared, should be washed, prior to being manufactured.

"As to the alleged increased purity of bilge water in ships built of the prepared timber, some that was pumped out of the *Samuel Enderbey* last autumn, was perfectly sweet."

Digitized by Google

75 Pages !!

Remarks on the Use of Mathematical Knowledge to Engineers, and Hints to those who have not the Benefit of a Tutor.

"What advantage does an Engineer derive from the study of Mathematics?" In connection with this question, we are naturally led to the consideration of the practical results, *generally*, in all branches of science to which the application of Mathematics has given rise.

There is, I believe, amongst the great mass of Engineers, a very decided conviction that, for any practical good to be obtained, they might as well learn Arabic as Mathematics, and, if a practical question be treated mathematically, especially if there be a lot of algebraic symbols mixed up with it, the conclusions arrived at by all this learning are looked upon, as "*very fine in theory, but*"—we know the rest. And they very naturally found this opinion upon the inutility of which mathematical knowledge has apparently been hitherto to their profession. A body of intelligent men would never have come to this opinion without some ground for it. If it be a mistaken opinion, it is one supported by so many seemingly just reasons, that it is well worth while to go into them, and examine carefully the real state of the case.

Now, in the first place, nothing strikes one more obviously than the fact, that, up to the present time, mathematical investigation has *scarcely been applied to the subject to any extent*, (*i. e.* by competent Mathematicians.) Till within the last fifteen or twenty years Mathematicians never dreamt of applying themselves to such subjects. And even now, how many books are there professing to treat of them? About a dozen, at most.

But, secondly, even of what has been done in this way, there is scarcely any portion of which practical men can avail themselves. And the causes are easily enough pointed out. The most prominent of these is the circumstance, that *the application of mathematical formulæ to practical cases requires*

Digitized by Google

several things to be known which mathematics cannot teach, and has nothing to do with. I refer of course, to the *physical* conditions, such as the strength of materials, &c. Now, until experiments have done their part, it is absurd to expect of Mathematicians that information which necessarily depends on the combined results of calculation and *experiment*. If astronomical *observations* did not exist, what would the science of Astronomy be? The dynamical part would consist of a lot of differential equations, crammed full of unknown elements, (such as masses, distances, periodic times, &c.,) all linked together certainly, and in such a way, that if a sufficient number *were known*, (from *observation*,) the rest could be found out. Now, just so it is with the mathematical science of Architecture, &c. If the strength of the beams, the tenacity of the iron, &c., be not determined by experiments, it is the same as if in Astronomy no observations had been made. Until such men as Barlow and Hodgkinson, in England—Morin, Girard, Cowlomb, &c., in France—have *observed*, it is of no practical utility for the Mathematician to *calculate*—that is, of no utility as regards the application of formulæ to *particular cases*. *General principles* may, of course be established, just as in Astronomy we might be sure, (provided we knew the general fact of attraction) that a planet would describe equal areas about the sun in equal times, without knowing anything of the absolute magnitude of the area, or of the time taken to describe it.

But thirdly, suppose we knew all the elements necessary to be known, the direction and magnitude of all the forces acting, and the geometrical conditions of the question, the *difficulty* of the purely mathematical part of the problem is often very much greater, and almost always of a very *different* kind from what the practical man would imagine. The mechanical phenomena of every day life are, in nine cases out of ten, immeasurably more difficult than some of those astronomical problems which seem to those unacquainted with them, so grand and mysterious. Thus, the spinning of a boy's top, is a far more difficult dynamical problem than

Digitized by Google

calculating the orbit of a comet; and it is an easier matter to assign the rocking and pitching of the earth itself, as it rolls on in space, than to calculate the motion of a cricket ball when struck by the bat, or the pitching and rolling of a ship at sea. The familiarity of a phenomenon is anything but a measure of its difficulty; and some of the questions proposed by the Engineer as probably the most familiar to him, are very likely to be of the highest order of difficulty, when it is endeavoured to substitute mathematical accuracy for practical approximations.

Except in some few cases (such as suspension bridges, for example, where mathematical calculation is immediately applicable, and experiments have been sufficiently numerous to determine the necessary constants) the present state of experimental knowledge is perhaps of itself sufficient to prevent the theoretical calculations from benefiting the Engineer in particular cases; it is therefore to those *particular* cases, it is therefore to those general principles, which are independent of these particular circumstances, to which he must look for benefit, if anywhere. What are these principles then? Are they such that Mathematicians only can understand and *use* them, or are they merely what every body knows from his everyday experience, and his common sense, without mathematical assistance?

Many persons seem to have a notion that *mathematical* reasoning is different from any other kind of reasoning: they apparently expect to be all at once enlightened from some mystical source, unapproachable except through a labyrinth of symbols; and in fact, the expectation of something like *magic* in the matter, is what chiefly allures them to the study, just as a belief in Astrology and Alchemy used to incite the worthy middle aged gentlemen to stick so pertinaciously to Astronomy and Chemistry. This is a very pleasant idea no doubt, and it is really almost a pity that it should ever have been knocked on the head; for, since then, people have lost all curiosity in these subjects, and after all, it would be a puzzler for the most "grave and reverend," stiff-necked and exalted

Digitized by Google

savant to make out any real distinction between the same "curiosity" and that "love of truth" which they make so much fuss about. I say then that it is a pity we cannot all delude ourselves into the good old fashioned belief that we are on the road to some grand secret, and that, from out of the cloud of mystery in which our operations are enveloped, there will burst forth upon our enchanted vision, some magnificent scene or sublime truth, not to be attained by any ordinary route, or conjured up by any but a cabalistic spell.

Unfortunately, the adventurer in this mystic region very soon finds, that he is obliged to *think*, and that too, in a very ordinary matter of fact sort of way; he finds he cannot *make the symbols think for him;* they are very serviceable "spirits" in their way, and the extent to which that service goes is considerable; but the charm does not reach indefinitely—and, as in the cases to which we are alluding, the real power of the charm depends very greatly in knowing *how far it does extend.* I have said that he cannot make the symbols "think for him," but they do the two following things which are both of inestimable value:—1st, they chronicle in logical order, and in a language of wonderful beauty, perspicuity and conciseness, his thoughts and reasonings. And 2d, by their *comprehensive* nature they suggest new forms of the original truth intended to be expressed by them—point out analogies and connections which would never otherwise have been thought of—and, in short, lead to the mine of wealth, although unable of themselves to put him in possession of it. But all these services are only rendered to those who are perfect masters of the symbolical agency. To carry on our simile, they will obey only him who possesses the spell by which they are bound—who knows how to evoke from their mystical answers, an intelligible result. Now, the only way to obtain this mastery—the only guide to the signification of these mysterious, and to the uninitiated, unintelligible language, *is* to become familiar with their use, beginning from the simplest questions. The whole subject of the interpretation of symbols, is one of inconceivably boundless extent; it is a

Digitized by Google

subject as yet only in its infancy when compared to what it will very probably one day become. What is termed the "calculus of operations," by Professor DeMorgan, or the results obtained by the separation of the symbols of operation and quantity, in the differential calculus, is an example of what has recently been done in this subject, but probably only a very small part of what will be hereafter done. The Mathematician is well aware of the immense importance of that to which allusion is here made; and the further he proceeds, the more strongly does he become convinced of the necessity of *knowing exactly what his formulæ mean*, from the very first processes of Algebra up to the most intricate part of definite integrals. For even the first Mathematicians, of the present or of former times, have only been partially acquainted with the full signification of this language, even to them, has a greater or less amount of *mystery* remained in it. For example what *meaning* would Euler himself have attached to the following formulæ which he, in the course of his numerous dealings with these symbols, *happened* to fall in with:

$$\mathrm{Cos}\,\theta\,\frac{1}{2}\left\{\varepsilon^{\theta\sqrt{-1}}+\varepsilon^{-\theta\sqrt{-1}}\right\}$$

It is only within comparatively a few years that any *attempt* even has been made to give a rational signification to such formulæ. There are many men who have a very good *working* knowledge of mathematics who if called upon to translate this into plain English, could give no other version except this, "Cosine of the angle θ is equal to half of a certain number (ε), raised to the power of the angle θ, multiplied by the square root of a negative quantity, plus, &c. &c." These things are merely mentioned as indicative of the importance and vast extent to which the subject of interpretation of formulæ really reaches. A sound and thoroughly rational acquaintance with the real meaning of the equations which are of *most common* occurrence in pure Mathematics, and of nearly every one met with in sta-

Digitized by Google

tics, dynamics, hydrostatics, &c., is obtainable without entering on such debatable ground as above alluded to; and the mysteriousness of the formulæ to beginners is only a proof that they have not given sufficient attention to the reasoning by which they are obtained. Some attribute this mysteriousness to the books, some to the readers, and some to the *mode* of reading. There being three parties accused, we must try each, and, as in most cases of this sort, find each guilty of something. It is satisfactory, however, to be able to throw the chief blame on that which has no feelings to be hurt, and could not defend itself if it had—viz. *the mode of reading*. The reader does not *think* enough,—the book is not *clear* enough; but the common way of learning from a book, or pretending to learn is of all three "most lame and impotent." Before proceeding to the subject of mechanical principles useful in a practical point of view, we shall return a verdict on each of the aforementioned criminals.

1st. *As to the Books.*—Of all the tasks undertaken by mortal men, probably the most difficult, wearisome and unsatisfactory to all concerned, is the writing of an elementary book on a scientific subject—most especially Mathematics. It has been more than once asserted by Mathematicians of the highest rank, and no doubt with a full conviction from their own experience, that *the principles* of a science are always those which are *learnt last*. That a full, clear, and *comfortable* grasp of those fundamental notions on which a science is founded, is only attained after a long course of intimacy with the *working of the details*. Suppose, however, this vigorous and comprehensive view of the whole is obtained, imagine the difficulty of attempting to place the same view, in its wide extent and clear light, before one who comes without any preparation, and as it were, out of Egyptian darkness! The thing must *necessarily* be done in *detail;* and it is this very disjointedness, and partial glympse sort of way, which causes the obscurity. Euclid is perhaps the only portion of the scene which can be compared to a progressive panorama,

Digitized by Google

where each part is clear and intelligible of itself, and view after view opens in lucid order and harmonious connection with what has preceded. Statics and dynamics on the other hand, are *tableaux*, which require to be gazed at and comprehended *piecemeal*, before the unity of the whole design is grasped, and the whole science taken in at one glance. Thus there must of necessity be many things of which the use cannot be seen, even if the meaning be understood, until a subsequent portion throws light on what went before, and each element finds its place in the final structure.

It has often appeared to me, that the only natural method of conveying a thorough knowledge of a general principle is to commence with the simplest example of such principle which can be found, and conduct by a series of wider and wider generalizations up to the principle itself. The exact contrary is the method usually employed. A general principle or theorem is enunciated in its most abstract terms; which terms themselves are seldom understood until after the student has seen the application to a particular case. In no part of Mathematics is this more obvious than in analytical Mechanics. But this is not all, or even the worst part of the charge: the one great and glaring defect in nine treatises out of ten, is the utter deficiency or miserable supply of elementary examples. One single example, or problem, carefully worked out, would do immeasurably more to clear up obscurities than ten thousand pages of *general* writing about it. The historical order in which the various theorems have been discovered, is not, *in every case*, the best adapted for the presentation of them to the beginner; but the general arrangement would, in most cases, be very greatly improved by a reference to this historical order. For example: the nature of the differential calculus would be set in a clearer light, by introducing the mode of applying it to the finding of tangents to curves, and some cases of maxima and minima, before the great mass of the abstract theory which is usually made to precede all application. And such was the his-

Digitized by Google

torical order, the general method of application to tangent being known long before Taylor's theorem, &c. were discovered. Dr. Ritchie has undoubtedly gone the right way to work in the little work on the differential and integral calculus which bears his name; although he has unfortunately very much limited its value, by leading his readers (perhaps unintentionally on his part) to suppose that the solutions of his problems depend on the *uniformity* of the motion which he everywhere mentions: thus confining the application of the calculus to very narrow limits indeed. Nevertheless it is the most likely book on the subject to give a beginner any notion of what the differential calculus really is good for, (with the exception, perhaps, of a recent book by Mr. Connell,) than any other of an elementary nature. I think it right, for the sake of any one who may possibly be induced by this recommendation to purchase this work of Ritchie's, to say that, in the recent edition which has been published, the editor has not kept his word; for having promised the answers to *all* the questions in his preface, it is found that almost the whole, of any difficulty, are *left* unanswered.

With regard to the existing treatises on Mechanics, it is almost impossible to select any *one* which can be said to be the best adapted to the beginner. They all exhibit the great and fatal deficiency of examples, without which every book —no matter by whom written—*must be unsuited* to the purposes of self-instruction. To make the matter still worse, there is no collection of easy problems on the subject, published separately, that I am aware of. Such being the case, the student must pick out here and there—at a great expense of time and money—that which it is the usual province of a private tutor in the various universities to supply—viz. illustrative examples worked out, and general hints as to the way of going to work. The student, if acquainted with French, (and every one who intends to acquire an extensive knowledge of Mathematics, or indeed of any science, will find an acquaintance with the French language indispensable—*i. e.*

Digitized by Google

so far as to be able to read scientific works, for which purpose, a very slight familiarity will go a great way—such as most persons have learnt at school, or may pick up in six months,) —if acquainted with French I say, cannot perhaps do better than take Poinsot's "Statique" as a text-book. It is the standard work on the elementary branches of the subject in France, and as being the production of one of the greatest Mathematicians of the day—of a man who has probably *thought more* about the principles of the science than any other—it holds a rank to which perhaps no other work (except Poisson's) can lay claim. Some very valuable memoirs on dynamical subjects are attached as a sort of appendix, which will be appreciated after some years' experience and knowledge of dynamical subjects, but probably not before. Poisson's two volumes *of course*, form an indispensable book of reference to those who go at all beyond the elements, and even in the elementary branches they are useful to those who have got some knowledge of the matter from other sources; but it is not a book for the beginner. There are a multitude of elementary compilations by French authors, few of which being known in England, or likely to be met with by the English reader, it is unnecessary to notice them. Françœur's "Mechanique" might perhaps be useful now and then, and is said to have been written under the direction of Laplace. Bossut's work on this subject, forming the third volume of his "Cours de Mathématiques," is an original work, and by a man who held a high place amongst the Mathematicians of his time. The subject of arches, roofs, &c. is very fully treated in the latter editions, (1802,) and the whole book likely to please those who dislike formulæ; but is not adapted to the modern method of solving mechanical problems.—Prony's "Leçons de Mécanique Analytique" is also the work of a very eminent Mathematician, and perhaps the earliest of those which established the present elegant form of the science, after Lagrange. The elementary portions, both of mechanics and hydrostatics, are also treated very fully in the first volume of the "Architecture Hydraulique," by the same

Digitized by Google

author, which however, is not at all a likely book to fall into the hands of English students. Within the last two years, M. Duhamel has published his "Cours de Mécanique del Ecole Polytechnique," in two volumes; but though several parts are of great value to the advanced student, the work is not at all a fit one for a beginner. Of all the recent French works on this subject, with which I am acquainted, the best adapted for those who are entering, for the first time, on it, and whose principal object is to apply practically their acquisitions, is the well known work of "Poncelet, called Mécanique Industrielle." This contains the substance of what was delivered as a course of lectures to workmen at Metz. This is in 2 vols., 8vo. There is another work, entitled, "Introduction ā la Mécanique Industrielle, Physique et Experimentale," 1 vol., 1839, by the same author, which I have not seen. Another very clear and well written work, with a somewhat similar object, is the "Traité de Mécanique," of M. Bresson, 1 vol. 4to. The author professes in his preface to have written it expressly for the use of practical men, and to have had extensive experience of their wants. So far as the general method of reasoning, and absence of analytical calculation goes, it seems to be what it professes. Indeed those parts which I have read are done more clearly and copiously than the corresponding parts of any other book that I know of. Its price, however, will necessarily be a great drawback from its circulation amongst those for whom, according to the author, it is intended; for very few will be willing to lay out a pound in one volume, which only treats, after all, of a small portion of the whole subject. Lastly, must be mentioned a work recently published, by M. Taffé, the object of which is to calculate numerically, for the different sorts of machines, the relation between the power applied and the work done, according to theoretical principles contained in the works of Poncelet, &c. I do not recollect the exact title of the book, which, however, may be easily ascertained at Bailliere's, in Regent Street, or any other importer of French scientific books.

Digitized by Google

Of English works I shall only mention what appear to me the respective characters of those with which I am acquainted, and from which the student is most likely to make his selection. Whewell's works on *Dynamics* are excellent, and fully deserve the reputation which they have procured to the author: from some cause or other they have fallen into partial neglect, which would not be the case if their real merit were as generally known as it ought to be. It will be understood that they are chiefly written with a view to their application to Astronomy, and therefore are not at all suited to the wants of the Engineer, even if he possessed sufficient knowledge of the differential and integral calculus to be able to comprehend them. This, indeed, may be said of all the treatises on dynamics written for University students, as might be expected. With respect to Whewell's "Mechanics" by far the best known of his works, it is already in the hands of so many persons as to render any remarks almost unnecessary. The great blemish of the statical part—that which entirely destroys the *philosophical nature* of the book—is the founding of the whole science on the properties of the lever instead of on the parallelogram of forces.

The clumsiness, and utterly unsatisfactory nature of such a method, is too obvious to need any remark. The Master of Trinity has got some queer crotchets on this subject of "the foundations of mechanics," in which he is totally at variance with all the great French writers, and which have, unfortunately spoiled his book as a *scientific treatise*. The other great defect appears to me to be the chapter on impact and collision, in the dynamical part of the treatise. This is done in a way which will satisfy very few persons except the author, I imagine. If the student, however, begins with "Duchayla's Proof of the Parallelogram of Forces," (or any other which may be satisfactory to him,) cuts out all the long bungling chapter on the lever, (except the fundamental property, which may be deduced from the parallelogram of forces in half a dozen lines,) and also substitutes some other book for the chapter on collision, &c., he will find the rest of

Digitized by Google

the work to constitute altogether one of the best courses of reading that he could meet with. The work on "Analytical Statics" requires a knowledge of the differential and integral calculus.

Earnshaw's "Statics" and "Dynamics" are both very excellent works, not compiled from others, but the production of one, who is one of the best authorities we have on dynamical questions. There are also a few tolerably easy problems worked out both in the "Statics" and "Dynamics"—more than in any other book that I know of, but still not enough of the "easy" ones. But the same remark applies to these as to other academical works—they are not *adapted to Engineers*, though Engineers may derive a thorough knowledge of first principles from them. "Pratt's Mathematical Principles of Mechanical Philosophy" is a work so exclusively adapted to University reading, that three-fourths of it would be useless to the Engineer; but for the *elegance* of its demonstrations and the "neatness" with which everything is done, it is unequalled. To those who intend to read physical Astronomy, it cannot be too highly recommended. Snowball's "Mechanics" is a book of which the less said the better. One wonders why it was ever written. The only explanation is, that, at the time it appeared, Dr. Whewell's *fifth* edition of his "Mechanics" being out of print, a sixth was published, in which, so far from *improving* and extending, the author had completely mutilated his own former editions—so much so, that if Dr. Whewell's name had not still appeared on the title page, the natural supposition would be that "an enemy hath done this."

Professor Lloyd of Dublin, published in 1826 a very valuable treatise on "Mechanical Philosophy," of which only the 1st vol. ever appeared, and is now rarely to be met with. Those portions of the "Mechanical Philosophy" of Professor Robison of Edinburgh, which relate to mechanics and hydrostatics, are of a more *useful* tendency than perhaps any other that could be named, except the works of Barlow and Hodgkinson on the strength of materials; but not only are the

Digitized by Google

4 vols. which contain Robison's articles very expensive and difficult to procure, but they require the possession of some previous information derived from systematic treatises. One cannot but remark, by the way, that the number of really valuable scientific works "out of print," and not to be had either for love or money, is a disgrace to our scientific literature. Whilst quack advertisements and reviews written after half an hour's casual inspection of a book, by one perhaps who "does the reviewing" on all subjects, from astronomy to dancing—whilst such puffery in the provincial newspapers, and impudent self-laudation in *all* papers is cheating a deluded reader out of his money for the most trashy and ephemeral rubbish—the great standard works of men who have devoted their lives to a subject, and only published what cost them years of intense thought, are allowed to sink into oblivion—the only chance afforded to those who know their value, of meeting with them, being at some old book-stall for a few pence, or by specially commissioning a bookseller to buy them *at any price*.

To return to the elementary treatises. Bridge's Mechanics contain several problems with their solutions, which would be useful: the rest of the work being written in the old style, this renders it of little use to those who wish to read modern works afterwards. There are also 2 vols. by Venturoli, translated by Creswell, which I believe contain several inaccuracies, and even gross blunders,—*otherwise* some good might be got out of them. Mr. Tate's unassuming little work has been too recently noticed in this Magazine to render any further recommendation requisite; the same may be said of Professor Moseley's large work, which, however valuable to the *mathematical* student and *Amateur* of engineering science, will, I fear, be found but little calculated to assist practical men. The labours and writings of Professor Barlow and Mr. Hodgkinson are far too well known, and I doubt not, appreciated, by the engineering body, to render any notice of them requisite. Their investigations, however, require a previous acquaintance with the general principles of mechanics, and

Digitized by Google

therefore would be unintelligible to those who attempted to read them without such preparation.

Perhaps on the whole, the following works taken together, may be the best that the beginner could commence with; "Earnshaw's Statics," the fifth edition of "Whewell's Mechanics," and for practical application "Mr. Tate's Exercises," and, especially, if he can read French, Poinsot's "Statique."

We come now to what is of much more importance than the books—*how to read them;* or rather, how to acquire a knowledge of the science. Of all the "vulgar errors" which exist, there is none which requires exposing more than the notion under which nearly every student labours at the beginning of the different sciences which he learns, that the obscurity and difficulty he feels are the fault of this or that book—and the fancy that if he could only meet with such a book as *ought* to be written, he should forthwith become all of a sudden illuminated. Being possessed of this hallucination, he tumbles over the leaves of the works which he has, and scrapes together with the most ludicrous eagerness all sorts and conditions of books—very greatly to the benefit of booksellers, and very much to his own discomfiture. Not one whit the wiser does he become for all this medley. I believe it would be found, if a statistical account were made up—that some thousands of young gentlemen have, one after the other in their day and generation, arrived after mature deliberation, at the very satisfactory conclusion that no one was so pestered, so bothered, so thick-headed, so "not-born-for-a-mathematician" as themselves. At the commencement of Algebra he is very certain that he shall never understand anything about it. When that is somehow or other got over, he is positive that plane Trigonometry is of that peculiar nature, *he* shall never comprehend it—and so on. Now there is some mischief—more than is perhaps often thought of, done by this pusillanimity; for a habit is got into of *expecting to find a great many things in mathematics which ordinary common sense cannot master.* A great many propo-

Digitized by Google

sitions they consider to be "proved" by a "sort of juggling," which for want of any other proof, they are content to admit; the original impression of the unsatisfactory nature of the "proof" gradually wears away, and thus there are in the "creed" of many (who possess what is generally considered an extensive knowledge of mathematics) no small number of theorems, and those too, sometimes of vital importance, which have been *received on trust*, more than admitted on evidence, and of which, if called upon, they could offer no rational demonstration. One instance to show my meaning will be enough. How many of those who consider themselves tolerably good mathematicians are there who have not received as proof of the principle of "indeterminate co-efficients," the one line and a half of which modestly requests you to "let $k=o$," and then comes down upon you with it;—Q. E. D.?

Let this be taken then as the *very first and most vitally important principle,—that no proposition in mathematical works is to be received, and* CONSIDERED AS PROVED, *unless each step is distinctly seen to consist of what is generally termed—good common sense reasoning.* It may appear very unnecessary to insist on such a point, but those who know anything of the capacity of swallow with which many students are endowed, will not think it at all unnecessary.

There is and can be, BUT ONE kind of reasoning; and those who talk of *mathematical reasoning* being of a different nature from other kinds of reasoning, *confuse* "reasoning" with the *results* of that "reasoning." A man may make the most absurd hypothesis imaginable, but reason it out as naturally as Euclid does any of his propositions. But that which gives to mathematics its superiority, is the clear conception of the subject reasoned about—which is not attainable in other sciences. To arrive at a *correct* conclusion, it is not enough to *reason* correctly, we must have *correct data.* Now, in physical science these data are only to be *in part.* For example, a result which *may* depend on the *pressure of the atmosphere alone,* or which may *also* involve its hygrometric state, has to be de-

Digitized by Google

termined. We may first *suppose* that it depends *only* on the pressure, and reason correctly on that hypothesis, but the result is not correct unless the hygrometric state be in reality without influence; or, which is perhaps a case more likely to happen in reality, we may have assumed this result to depend on both these two quantities, viz., the pressure and the quantity of moisture in the air; but *suppose* the latter quantity to be unaffected by the former. If it should turn out that they are mutually dependent, our conclusion would be incorrect, though our reasoning were as good as Euclid. But suppose we had to settle the question mathematically—calling one quantity *(x)* and the other *(y.)* We might (if the differential and integral calculus were required in the solution) first, go through the calculation on the hypothesis of their being *independent* variables; and, secondly, make one a function of the other. While therefore the *physical* question would necessarily remain undecided—so long as we remained ignorant of the real laws of nature on the case—the *mathematical* question could be completely solved, and the result ready to be applied to the physical question, as soon as ever future inquiry should determine which of the two sets of calculations was to be taken.

There are also the same fallacies possible in mathematical processes as in any other; the same "symbol" may be inadvertently used in different significations, just as the same "word" may in non-mathematical argument. A result may be attributed to a wrong cause, or cause and effect confounded in a long train of analytical investigation—just as similar errors may occur elsewhere. It is true, this seldom happens in comparison with other sciences; but the liability to error must be constantly guarded against by the student, as an occurrence not at all impossible. As an example of a very common fallacy, which has been committed to a very serious extent by even great mathematicians, may be mentioned the confounding two distinct meanings of the symbol (=), one of which is "*arithmetrical equality*," the other, "*symbolical equivalence*," as nearly as common language can ex-

Digitized by Google

press them; which two meanings are perfectly distinct. There are two remarks in Professor De Morgan's "Differential Calculus" which will illustrate what I am referring to: "I think Legendre has very obviously fallen into this misconception; but it has led him to no false results. Indeed, it is obvious that confounding, 'A may be written for B,' with 'A is equal to B,' though it must affect the logic, may not affect the result of a process." In another place he has noticed another fallacy, viz., the supposing that because "A results from B," it cannot result from "*anything else but B.*"

No blind reverence and submission is therefore to be paid to a process, merely because it is an algebraical or analytical one. But, on the other hand, the student must not throw aside as useless, or reject as nonsense, even those theorems which he may suspect to be fallacious, and for this reason, that what may be fallacious, when *one* meaning is attributed to the symbols (either by author or reader) may become perfectly true and satisfactory when *another* meaning is attributed to them. Now this attributing of wrong meanings, is one of the commonest sources of difficulty to the reader, and sometimes of error in the author. One of the first points, therefore, to be settled is, the signification of the terms or symbols used. When the reader sees two or more meanings, and is confused between them, he must take each, in order to try whether that will give an intelligible process, and here may perhaps be the proper place, to notice one source of confusion which lies at the root of one half the difficulties usually encountered, viz., *the utter misconception of what the quantities are which the mathematician deals with*, or, in other words, *the confounding things themselves with those other and merely abstract magnitudes used to measure them, and compare one with another*. For example, it is not uncommon for the beginner in dynamics to go half through a treatise, or even through a good many, without attaching any definite, or at any rate, correct notion to the letters F, P, *f*, &c., used to denote the forces reasoned about. If it be an attracting force, he very

Digitized by Google

likely conceives the P or F to stand for a magnet, or some *occult quality* in the magnet; and, truly, to him it is "occult" enough; Aristotle's were nothing to it, if F or P is stated by the author to "denote the force of attraction of a planet, &c." it is the planet or some occult influence in the planet, which he somehow associates with this letter P or F, and a precious jumble he makes of the matter. In statics the same notions are just as common, but not productive of the same confusion and mischief, because he has from daily experience, acquired unconsciously, something which almost supplies the place of a formally admitted and distinct notion. Thus, while he still represents to himself the meaning of P, Q, H, &c., by the actual bodies, such as a mass of iron, &c., instead of by the NUMBERS of pounds or the RATIOS of such numbers, he nevertheless has a much more sensible notion of the reasoning than in dynamics. Even in pure mathematics where there is comparatively so little room for such misconceptions, he is not free from them. Thus he confounds the "Angle" of Euclid with the analytical angle; and wherever he sees θ, ϕ, &c. instead of a *ratio*, he thinks about an *opening*. There is a sad deficiency of explanation of these fundamental steps in most writers on these subjects. But a really sound mathematician, who is writing for the purpose of giving his readers some common sense information, will not omit such observations. As an instance of this I may mention Airy, who begins his masterly "Treatise on Gravitation" by such requisite preliminary explanations: another instance of this anxiety in the same writer, to make the reader remember what he is about, occurs in a note to his tract on the "Figure of the Earth." If once a firm and deeply rooted conviction be felt (which, however, can perhaps only be obtained by *experience*), that all mathematical processes are to be judged of by the same common sense, as any other reasonings, and that the symbolical language in which they are conducted, though of infinite value as an *assistant* to the memory and reason, does not the less render them amenable to the same supreme tribunal as the commonest and least dignified subject—if this be at once attained, I say, it will be

Digitized by Google

ever afterwards a safeguard against that irrational and unphilosophical submission to half understood propositions, which goes so far to mystify the student and prevent his advancement in science. The aphorism of Bacon may be applied to this subject as well as to the study of nature:—"Homo, naturæ minister et interpres, tantum facit et intelligit quantum de naturæ ordine re vel mente observaverit; nec amplius scit aut potest;" or changing a few words in Sir John Herschel's translation, "Analysis, as the minister and interpreter of reason, is limited in process and result by its conformity to reason; neither its evidence nor its results extend further."

The misconception of the real use of analysis has been exposed by Poinsot in several places. In his Memoire sur "L'Equateur du Systeme Solaire," the following passage occurs:—"Cet exemple nous fait sentir toute l'importance qu'on doit attacher aux notions primitives et aux vrais principles des choses; car le calcul n'est qu'un instrument, qui ne produit rien par lui même, et qui ne rend en quelque sorte que les idées qu'on lui confie. Si nous n'avons que des notions imparfaites, ou si l'esprit ne regarde la question que d'un point de bue borné, ni—l'analyse ni le calcul ne lui apporter ont plus de lumière, et me donneront á nos resultats plus de justesse ou plus d' ètendue; au contraire, on peut dire que cet art de réaliser eu quelque sorte par le calcul, de fausses on de vagues conceptions, n'est propre qu'á rendre l'erreur plus durable en lui donant pour ainsi, une sorte de consistance." For some further observations—explaining the cause of these erroneous views as to the real province of analysis—I must refer to another Memoire, "Theorie nouvelle de la Rotation des Corps," which deserves the most considerate attention, as the opinion of one who has spent a long life in thinking and establishing principles, instead of mere dabbling amongst analytical artifices. Of course, the principles, of analysis require a deep and patient thought as the principles of mechanics, and are no doubt still more difficult; but there is all the difference in the world between him whose

Digitized by Google

claim to mathematical honors rests merely on the application of principles (often little more than a mere mechanical operation) and another who places fundamental principles on a sound and clear basis, for when this is accomplished, the application is easy enough. I shall make one Extract from the Memoire. "C'est un nouvel exemple qui montre l'avantage de cette methode simple et naturelle de considerer les choses en elles-mêmes, et sans les perdre de vue dans le cours du raisonnement; car si l'on se contente, comme on le fait d'ordinaire de traduire les problèms en equations, et qu'on s'en rapporte ensuite aux transformations du calcul pour mettre au jour la solution qu'on a en vue, on trouvera le plus souvent que cette solution est encore plus cachée dans ces symboles analytiques qu'elle nel'était dans la nature même de la question proposée. Ce n'est donc point dans le calcul que reside cet art qui nous fait decouvrir, mais dans cette consideration attentive des choses, on l'esprit cherche avant tout á s'en faire une idèe en essayant, par l'analyse proprement dite, de les decomposer eu d'autres plus simples afin de les revoir ensuite comme si elles étaient formées par la réunion de ces choses simples dont il a une pleine Connaissance. * * *

Ainsi notre vraie methode n'est que cet heureux mélange de l'analyse et de la synthèse, ou le calcul n'est employé, que comme un instrument; instrument precieux et necessaire sans doute, parce qu'il assure et facilite notre marche; mais qui n'a par lui—même aucune vertu propre: qui ne dirige point l'esprit, mais que l'esprit doit diriger comme tout autre instrument."

"Ce qui a pu faire illusion a quelques esprits sur cette espece de force qu'els supposent aux formules de l'analyse, c'est qu'on en entire, avec assez facilite, des berités déjà commes et qu'on ya, pour ainsi dire, soi-même introduities; et il semble alors que l'analyse nous donne ce qu'elle ne fait que nous rendre dans un autre langage."

Instances of this "extracting from analysis that which we put in," are found in most writers. Such expressions as this, after a long row of equations: "*hence* we see, &c." *This*

Digitized by Google

shows us that, &c.;" when all that is "seen" and "shown" by these equations is generally something as clear as daylight of itself, or very obvious before the equations were manufactured. This solemn manner of arriving at truisms, this much ado about nothing; this killing a gnat by a cannon ball, reminds one of Hudibras's "telling the clock by algebra," or the mountains in labour bringing forth "ridiculous mus." What for instance, can be greater humbug and tomfoolery than to enunciate formally, and then attempt to *prove* (!) mathematically, that if the vertical line through the centre of gravity fall without the base the body will tumble over? not content with this, we must have a long string of corollaries, in one of which a grand secret is disclosed, the result of all this profound gabble, viz. the "explanation of how difficult it is to balance a body upon a *point* placed immediately under its centre of gravity!!" Blessings on their learning! Here is something worth communicating *pro bono publico*. Imagine the author to go up to a little urchin trying to stand or walk along some railings, "my dear child, after much cogitation, and by the aid of a very powerful analysis, I have arrived at this theorem, that if you attempt to stand bolt upright on this spike, which approximates, as you observe, practically to a *point* you will infallibly topple over, *because*, &c. &c.; and it might not be difficult to derive as a corollary to the laws of percussion—if proper data be given of the elasticity of your noddle and the height of the railings—that you will be more or less smashed." Now really this is not one whit more ridiculous that the "conclusions," and even "practical" suggestions to which grave authors sometimes arrive. No doubt, some of these absurdities have contributed to bring the whole subject into contempt with practical men when they see so very little wool after so very great a crying.

I have dwelt longer on the subject of "The rise and abuse" of analysis than may appear necessary; but those who know how much depends on correct views of this point, and how few students there are who do any thing more than "juggle"

Digitized by Google

with it, especially in attempting the solution of problems, will acknowledge its full importance. For example, a problem in analytical geometry is tried—a locus is to be found; well, instead of thinking carefully about the geometrical conditions of the case, and merely using the transformation of the equations *with a definite view* he begins by writing down this equation, and that equation, and every thing he can think of, and hopes by some lucky shuffling and lodging to get at the result. He may be fortunate enough in some instances to do this—generally after immense toil and waste of time, and by a complex and inelegant method. This is, indeed a branch of analysis in which there is more room for chance solutions and effecting a thing by lucky choice of co-ordinate axes, &c. &c., than in any other; but it is still far from being so dependent on chance as students imagine; and at any rate they have no ground for expecting to fall in with these "lucky hits" if they have not attentively considered the problem before applying their algebra. In mechanical problems, however there is scarcely any thing that depends on chance, nothing but a clear conception of the whole of the forces acting, &c. &c., will ever lead to the solution. "Rein ne nous dispense," as Poinsot says, "détudier les choses en elles mêmes et de nous bien rendre compte des idées qui font l'objet de nos speculations." Indeed it is this preliminary "consideration of things in themselves," which constitutes the whole difficulty nearly of every problem of every science. Most students soon acquire sufficient mechanical dexterity in handling the algebra, the trigonometry, the differential calculus, the integral calculus, &c., to render the part which depends merely on such transformations a simple exercise of the pen and ink. And yet it is to this low and subordinate part which they are most eager to hurry—for this simple reason, that it costs them no thought, and is, in fact, a mere amusement dignified by a grand name. It is indeed, a very pleasing relief to the mind and as it were the reward of one's labour; but it is a very great mistake to fancy that we have learnt anything from all this portion—often indeed by far the

Digitized by Google

greater bulk of the solution. Take, for instance, the lunar theory; supposing the student to know the principles from which the equations of motion are derived, what intellectual exercise is there in the long and wearisome process of integrations and approximations, which constitute the great bulk of the treatises on this subject? If the reader were to attempt to perform these integrations *by head* without using his pen, then, indeed, he would have to think hard enough and very soon get inextricably confused and distracted; such an effort of thought would moreover be exceedingly absurd, and a mere waste of time and energy, inasmuch as the writing down each step relieves the mind without injuring the reasoning; and is in fact, the only possible way of managing such calculations. But when he has got through this merely mechanical operation, and comes to the physical and common sense *interpretation* of his analytical results when he has to "explain the effect of the various terms," of these equations, showing how one is connected with the motion of the moon's perigee, another with the eccentricity of her orbit, &c. &c., then he has to *think* and the dry and lifeless mass of formulæ is found to be full of real, tangible common sense meaning, and the task of interpretation is a thoroughly intellectual one, and the only part which deserves to be called "profound."

We impose upon ourselves by words. We give the appellation of "profound analysis" to a long study of differential equations, integrations, &c. &c., which might almost be as well done by Babbage's machine and we forget that the only "profundity" is in that part which requires patient and intense thought. We cajole ourselves by fine words, and very often writers mislead their readers also, so as to give them the bare rind and bark to admire whilst the pith and heart of the whole is neglected; I refer to some historians of science, and not to the writers of treatises on the subject. I am persuaded that the real merits of many great men have been thus mistaken and wrongly appreciated.

Engineers have sometimes been reproached, and not with-

Digitized by Google

out reason, with misconceiving the real source of that power which they direct and control; and a similar charge may be brought against many mathematicians. As in the one case, a spectator, ignorant of the real use of machinery, might judge from the admiration with which the Engineer contemplates its beautiful arrangement and motion that *in it* lay the whole power; so might the uninitiated listener be deceived by the admiration with which the mathematician views the symmetrical machinery of calculation, and go away with the notion that some wondrous engine was at work in all this mystic array of formulæ, which belonged more to the regions of enchantment and supernatural power, than to the domains of plain sense and every day reasoning. There is indeed an exercise of the intellect in that perception of the adaptation and mutual dependence of seemingly unconnected parts which the practical eye of the Engineer so thoroughly understands; but how far short does this stop of the whole mystery—how inferior is this partial view to that which should at the same time take in the whole chemical action by which the steam is ultimately produced—and so recognize, in the simple tendency of carbon and oxygen to unite, the source of the whole power displayed? As yet no one can attain this state of perfect comprehension, inasmuch as nothing is known of those ultimate motions in which chemical phenomena consist: and here then the mathematician has considerably the advantage. Not only may he distinctly see and trace, step by step, the deduction of formulæ pass from one equation to another—this is but a very inferior exercise; the mere comprehension of machinery; but he is able to go to the source, and set clearly before his eyes each step from the beginning. It is true that such a course is often extremely difficult and sometimes would be labour thrown away, it being frequently quite as satisfactory to *know that a certain result is true,* as to see *by what successive steps* it *is* so. But in many cases the whole interest lies in this seeing *how* a thing is true, as distinct from the mere knowledge that it is true. In this clear perception of "*how*" results are obtained, lies by far the

Digitized by Google

chief difficulty of the student's reading. In the words of Sir John Herschel: "There are cases in the application of mechanical principles with which the mathematical student is but too familiar, where, when the data are before him, and the numerical and geometrical relations of his problems all clear to his conception—when his forces are estimated and his lines measured—nay when even he has followed up the application to his technical processes, and fairly arrived at his conclusion—there is still something wanting in his mind—not in the evidence, for he has examined each link, and finds the chain complete—not in the principles, for those he well knows are too firmly established to be shaken; but precisely in the *mode of action*. He has followed out a train of reasoning by logical and technical rules, but the signs he has employed are not pictures of nature or have lost their original meaning as such to his mind; he has not seen as it were the process of nature passing under his eye in an instant of time, and presented as a whole to his imagination. A familiar parallel, or an illustration drawn from some artificial or natural process, of which he has that direct and individual impression which gives it a reality, and associates it with a name, will in almost every such case, supply in a moment this deficient feature, will convert all his symbols into real pictures, and infuse an animated meaning into what was before a lifeless succession of words and signs.

* * * *

The contention of mind for which they call is enormous; and it may perhaps, be owing to their experience of *how little* can be accomplished in carrying such processes on to their conclusion by mere ordinary *clearness of head*, and how necessary it often is, to pay more attention to the purely mathematical conditions which ensure success,—the hooks and eyes of their equations and series,—than to those which enchain causes with their effects, and both with the human reason; that we must attribute something of that indistinctness of view, which is often complained of as a grievance by the earnest student, and still more commonly ascribed to the

Digitized by Google

native cloudiness of an atmosphere too sublime for vulgar comprehension.

In the preface by Airy to this treatise on gravitation, are the following similar remarks:

"The exercise of the mind in understanding a series of propositions, where the last conclusion is geometrically in close connexion with the first cause, is very different from that which it receives from putting in play the long train of machinery in a profound analytical process. The degrees of conviction in the two cases are very different. It is known to every one who has been engaged in the instruction of students at our universities, that the results of the differential calculus are received by many, rather with the doubts of imperfect faith than with the confidence of rational conviction. Nor is this to be wondered at; a clear understanding of many difficult steps, a distinct perception that every connexion of these steps is correct, and a general comprehension of the relations of the whole series of steps, are necessary for complete confidence. An unusual combination of talent, attainment and labour, must be required to appreciate clearly the evidence for a result of deep analysis. I am not unwilling to avow that the simple considerations which have been forced upon me in the composition of this treatise have, in several instances, contributed much to clear up my view of points, which before were obscure, and almost doubtful. To the greater number of students, therefore I conceive a popular geometrical explanation is more useful than an algebraic investigation. But even to those who are able to pursue the investigations with a skilful use of the most powerful methods, I imagine that a popular explanation is not unserviceable. The insight which it gives into the relation of some mechanical causes and geometrical effects may powerfully, yet imperceptibly, influence their understanding of many others which occur in the prosecution of an algebraical process."

One cannot help remarking here the influence of *words*. The expressions, "*profound* analytical process," "*deep* ana-

Digitized by Google

lysis," occurring in a passage whose very object is to show the insufficiency of these *alone* in a philosophical and rational point of view, is a very striking instance of our great proneness to impose on ourselves with fine words, or be imposed upon by others. The "depth," the "profundity," is obviously *not* in "the long train of machinery," but in that patient and determined effort by which the common sense of a process is grasped in spite of the misty veil thrown over it by the dark clouds of symbolism. Let us understand clearly and exactly what analysis is good for. It is not to show how, but to *calculate* how much. Then, if the forces, &c., of a mechanical problem be given, the analysis will not, and is not intended to show us *how* and *what kind* of motion will ensue—but to calculate *how much* of the effect is due to each force, and the place where, and time when, any particular effect will have been produced.

It is no doubt, a frequent source of discouragement to the beginner, that he finds himself most bothered and perplexed by those parts of a treatise or problem, which he has been led to consider the most common place and easy.

All that part of a book which is "plain English" he is apt to fancy *ought* to be the easiest. That difficulties should occur most plentifully in the mathematical part, is what he generally thinks most likely and natural; and when he finds that the "mere talking part," "the common sense and plain English" is really to him the most difficult, he is very apt to accuse himself of stupidity. I refer now, more particularly, to those portions of mechanical treatises in which the principles are discussed or rather slurred over in the fewest words possible. Now, if the student will only recur to the history of the science he will soon find cause to consider the matter in a very different light. When he sees such men as Galileo Huygens, Wallis, Bernoulli, some of the greatest men that even mathematics can claim—when he sees such men as these struggling year after year to grasp some principle, or comprehend some theorem which is now,—thanks to them, found in the very elementary branches (such as accelerating force,

Digitized by Google

impact and collision, &c.) he will no longer be ashamed of his own slowness of comprehension and will henceforward look upon the thorough understanding of "principles" as both requiring and deserving a far greater "contention of mind" than any mere algebraical development. He must not grudge any time bestowed on such matters, for it will be amply repaid him afterwards. As Professor De Morgan says, they "are apt to be discouraged by the apparent slowness of their progress, *which they measure by the pages read* without any other consideration."

It frequently happens, that one or two sentences thoroughly mustered will carry the reader on at one bound over some scores of pages afterwards. It takes some time to get the steam up, but when it is, you may dash onwards at the speed of a hurricane.

Next to a sound and healthy brain the most valuable acquisitions to a student, are pens, ink and paper. Few know their value. It may be all very well to sit reading by the fireside when the book goes on all smoothly and easily—but the instant any real difficulty occurs, there is no help like that of writing. Most students are in the habit of using this for the algebraical processes required; but this is but a very small part of its real value—of all the stumbling blocks in the student's way, by far the greatest are those cases in which *he cannot mention exactly where and what the difficulty is;* cannot point out any particular step or state in precise terms the things he does not see.

It is in such dilemmas as these, where the mind gropes about in a misty vacancy, and finds itself utterly bewildered in a labyrinth of indefiniteness—where all the ideas are jumbled in one tangled mass of confusion it is here that the real use of writing may be appreciated. The very act of writing aids in the concentration of thought. It enables the mind to exclude and bar off all extraneous notions; chronicles those which are relevant to the subject; and, to use perhaps a queer comparison, may be compared to the barrel of a gun, which prevents the power from expanding in a

Digitized by Google

useless direction, and compels the whole energy to act in a definite and useful direction. At first there may be all sorts of vague and good for nothing ideas crossing the mind, having nothing to do with the question, and only embarrassing the view by their presence. These are got rid of. Others there may be, pertaining indeed to the subject—but wrong. By clearly stating them their inapplicability is perceived. All the notions which the student has of the meaning or connection of a process may thus be exhausted, without finding in any of them the solution sought ; but this is either so much rubbish cleared away, and therefore so much in direct benefit ; or what is more likely, this attentive examination will have furnished him with the clue required, and will almost certainly be found of advantage in some part of his future progress or reading on the subject in question. It is hardly possible for attentive thought to be absolutely unrewarded. Most persons must have observed that in their endeavours to understand certain theories, or processes, or facts, objections have occurred or difficulties been seen, which, although found to be beside the question or without influence on the truth of the proposition considered, have yet been of the greatest value in some way or other afterwards. This is especially the case where things are true *only under certain conditions.*

The attentive examination of every possible way in which a change of conditions can alter the result, is often of the very highest importance ; and though it may seem at the time that much labour and thought has been wasted, it is not so. After cases will be met with in which this very change of circumstances will occur, and the effects of such change become exactly the question inquired into.

The subject last alluded to, namely, the examination of the conditions under which certain propositions are true, is one of the most important in mathematical reading. It is the very great neglect of this examination which causes that loose and irrational way of "getting up" subjects which is so common. A proof may be got up so as to be written out in literal accordance with the book ; but directly any application

Digitized by Google

to problems is required, the nakedness of the land is discovered. Nay, more than this, the proof may be so far understood, that no objection can be offered, and it may therefore be received with that "imperfect faith" which sees half and believes the whole—cannot see why it should be so, nor why it should not be so. Now, if the several conditions of every proposition were carefully looked into, not only would the validity of the proof be perceived, but it would be seen how the whole is brought about—how much depends on this condition, and how much on that,—in what way the reasoning would fail if such a condition were taken away, and how it might still be true if another circumstance were absent. It is this distinct perception of the part to be attributed to each element of the question,—the alloting of the separate functions, and the combination of separate effects into one final result,—it is this which constitutes the understanding of a process.

It would not be a bad plan in some instances—especially where there is any indistinctness of view as to the conditions—to set to work and attempt to prove that the proposition is not true. By such an attempt the truth would come to light. A very frequent source of error to the beginner in every branch of mathematics, is the very imperfect view he has of the generality of the theorems proved. He is apt to confine his thoughts to the particular data of the question, and to imagine that what is said applies only to his own limited suppositions. For example, in so simple a thing as the proof that $\cos^2 A + \sin^2 A = 1$, he attaches such notions to (A), that when afterwards he sees it assumed that $\cos \frac{2A}{2} + \sin \frac{2A}{2} = 1$ also, he may be surprised, and not improbably set it down as a glowing untruth, arguing, perhaps, "if true for A, it cannot be so for half A." If he had written down the above formula in words, (cosine of any angle)^2 (sine of same angle)^2=unity, he would see at once that the particular size of the angle had nothing to do with it—was not, in fact, one of the conditions of the proof. Or, to take another instance, there are no doubt, many persons who, after going through

Digitized by Google

the investigation, in statics, for the conditions of equilibrium of a rigid body, and arriving at the six equations necessary, on coming afterwards to the enunciation in words of these algebraical results, have perhaps been surprised to see that any three rectangular lines, meeting in a point in the body, or rigidly connected with it, may be taken as that to which the movements, &c. are referred.

Notwithstanding all the efforts made, there will be things left in obscurity if the student has no one to consult. In such cases he must take the advice of D'Alembert:—" Allez en evant et la foi vous viendra"—go on, and confidence will come to you." That is the acquaintance with what comes after will throw light on the preceding; but here it must be again repeated, that there is danger of receiving on trust, and not recollecting that it was so merely on trust. There is great risk of that which was received provisionally becoming so familiar by habitual use, as to lose its character of a mere assumption. If such gratuitous assent is necessary, some means of marking and branding it as an unwelcome intruder should be taken, otherwise it will prove an insidious foe. I need hardly say, that the constant working of examples and problems is the only way of acquiring knowledge, really worth any thing. Most especially is this true in mechanics. It was by the discussion of numerous problems that the science itself was formed. The Bernoullis Huyghens, Clairut, D'Alembert, and above all, Euler were incessantly problem-solving. By varying the conditions of each case—by gradual extension of particular results; by this slow and growing process was obtained that generality which now characterizes the science. And in the same way as it was slowly and laboriously built up, must the mind of the student be conducted from the simple example to the general and abstract theory. Of course, he has an immeasurable advantage in the labours of others presented to him; but this will not dispense with his going through a similar course, though it will accelerate his progress.

There is a sad want of good collections of examples worked

Digitized by Google

out, and even of the bare questions themselves. The reason is easily enough found. Where there are a hundred men who, by cabbaging from others, can manufacture an "elementary treatise," there is not one who is capable of producing a good serviceable collection of problems, solved as they ought to be. Walton's Mechanical Problems is the only one on this subject that I know of. This the student, who is a little advanced, will find extremely valuable, but there is not a sufficient number of the easier examples for those just commencing. Some of this sort (with their answers, but not solutions) will be found in a useful collection by Messrs. Wrigley and Johnstone, which comprises examples in most of the elementary branches of Mathematics. It would have increased the value of the book if rather more care had been taken in stating the problems; for in this, as well as in so many other cases, it is often as difficult to find out what the problem is intended to mean as to solve it when found out. Some tolerably easy problems will be found solved in Earnshaw's Statics, and various others may be got from the older books, as Bridge's Mechanics, &c. Bland's Philosophical problems and Mechanical problems contain a large quantity, selected from the Cambridge University Papers, but without any answers, and so are of little use to the student. I have often wondered there are no French collections on this subject. Surely, problems must be constantly proposed at the "Ecole Polytechnique," (or else their training is not good for much); but the only two books containing any questions at all, that I know of, do not contain a single example in mechanics.

We come now to the consideration of Mechanical principles. So far as the theory is concerned, there is little that can occasion any difficulty in the statical part of the subject. The practical application of the conditions of equilibrium, of course requires the consideration of the structure and strength of the materials used; and this at present is but very partially understood.

The properties of "moments" of forces is perhaps the only

Digitized by Google

portion of statics requiring any further notice than may be found in the usual treatises; but this admits perhaps of illustration, better from dynamical considerations than statical. However, we may remark, that their properties are proved, and the conditions of equilibrium of a body subject to their action obtained, by indirect means, in every work and method of treating them. The reader must have observed that, in order to get at the results, new forces were supposed to act: these are such as not to alter the equilibrium, certainly, provided the body be perfectly rigid, but they are nevertheless, altogether extraneous and foreign to the question, inasmuch as they were not originally contemplated. Before we could see how these effects are produced, we should have to examine how the property of rigidity influences the result: in fact, it is a question as to the transmission of force from one particle of a rigid body to another. We make use of certain results of this property of rigidity in the very supposition that the application of new forces will not alter the arrangement of the particles.

Even Poinsot has left this point without any elucidation. He has proved indeed, that the effect of a "couple" is measured by its momentum; but this proof requires the introduction of new forces, by combining which with the original ones, the result is obtained; but we are as much in the dark as ever with regard to the seeing how and why the increase of distance between the two forces should increase the rotary effort. In a note to the second edition of Pratt's Mechanical Philosophy, the conditions of equilibrium of a rigid body are elegantly deduced from those of a single molecule; but the process involves the illumination of the unknown moleculæ forces, by aid of analysis, without throwing any light on the real difficulty. At first sight, there appears to be in this increase of effect from mere increase of distance between the acting forces, a gain of power, which is explained by most writers by saying, that what is gained in power is lost in time. This is very easily seen if motion be supposed, but when every thing is absolutely at rest, this dictum falls to the

Digitized by Google

ground at once. Take, for a simple example, the lever. How can we explain the fact, that a weight of 10 lbs. at one foot from the fulcrum, will counterbalance 20 lbs. at half a foot (every thing being supposed at rest) without admitting an absolute gain consequent on increase of distance? Not one syllable has ever been written capable of explaining this. If, indeed, the state of rest be considered as the limit of gradually diminishing motion then the ordinary explanation will do. For, so long as there is any motion at all, the greater mass moves with a proportionably less velocity. Here then, we find recourse to dynamical considerations to be the only way of getting a satisfactory account of a statical principle. In fact, whenever we come to examine carefully into the nature of forces from a consideration of their effects, amongst those effects we invariably recur to motion and its various degrees of intensity, as their most natural and obvious exponent. It is altogether fallacious to consider the properties of equilibrium and motion as different in the nature of things, however convenient to treat of them separately. The general problem is this; a given mass is acted upon by various forces at different points of the mass—find the effect. Of this effect, equilibrium is a particular case, viz., when the forces happen to be related to one another in a certain particular manner; but the general effect is obviously motion. Every attentive reader on these subjects, must have observed, that in that portion of the science to which the name of dynamics is given, the effect of each force and its influence on the others is capable of being traced, and a more satisfactory account given of the part performed by each, than in the "statical" portion. The bone of contention, the "principle of virtual velocities," is just in the condition of the bat in the fable—being on the confines of two territories usually considered quite distinct—it participates in the nature of two species, and is alternately rejected by both—it is neither beast nor bird—neither statical nor dynamical. As to its signification, the truth of which it is the enunciation under a form adopted to calculation is simply this:—If the force acting on a mass, or system of rigid

Digitized by Google

bodies, be such as to destroy each other's effect statically, they will also dynamically; that is, if the system be any how in motion, the whole mass moved in any given direction, has its counterpart in an equal mass moved as much in the opposite direction, so that the mean or average effect, as measured by the quantity of matter put into motion in any given direction, is nothing, or if once the system be at rest, the continual tendency to an average motion in one direction is counteracted by an equal tendency in the opposite direction. Robinson in his Mech. Philosophy (vol. I. page 157) has stated this principle wrongly; his words are, "In the same way the celebrated mathematician De la Grange observed, that a system of bodies acting on each other in any way is in equilibrio, if there be impressed on its parts, forces in the inverse proportion of the velocities which each body takes in consequence of their action or connexion, &c." Now this is not true, except in the particular case where only two forces act. For if we take three for instance, P, Q, R, and call the vertual velocities of these, dp, dq, dr, respectively, the formular is,

$$Pdp \pm Qdq \pm Rdr = o.$$

Now if each force were inversely proportional to its own vertual velocity, we should have then,

$$\frac{P}{Q} = \frac{dq}{dp} \text{ and } \frac{P}{R} = \frac{dr}{dp},$$

and by substitution,

$$dp \pm dp \pm dp = o,$$

which is impossible, whatever sign be taken for dq. and dr. If, however, there be only two forces, so that

$$Pdp \pm Qdq = o,$$

$$\text{then } \frac{P}{Q} = \frac{dq}{dp},$$

and Robinson's enunciation is correct.

We come now to the consideration of the laws of motion. Starting from the principle that whatever produces *any alteration* in the state of bodies, either as to the velocity or direction of their motion, is capable of being measured and compared with other causes of similar alterations, we see that the subject is one capable of mathema tical investigation only so

Digitized by Google

far as this *comparison of the effects* of different forces is concerned. Mathematics has nothing whatever to do with the physical nature of the forces which produce motion or alter it. If a bar of iron is put in motion by the attraction of a magnet which acts uniformly, and produces a certain velocity in a certain direction after acting during a given time; and if a man, by pulling a string attached to the bar of iron, produces the same velocity in the same direction, and after acting for the same time, as the magnet, and does this uniformly —then so far as the Mathematician is concerned, the two cases are absolutely the same. The circumstances to be considered, and the only ones, then are,—1, The quantity of matter put in motion or acted upon; 2, The direction in which the body moves; 3, The velocity of that motion; 4, The time during which these effects are produced.

When we say that one force is *equal* to another, the only meaning is, that the effects produced under the same circumstances are the same for the two forces. In *measuring* a force, we must select some one of these effects; as for instance, the velocity produced in a given mass in a given direction, and after the force has acted a certain time; and if we notice that, whilst the three later circumstances, viz., of time, direction, and mass, remain the same, one force produces double the velocity which the other does, then we say one *force* is *double* the other. But if, whilst the mass moved and direction of motion remained the same, we allowed the time to be different in the two cases, we could no longer assert anything as to the relative energies of the forces from the *velocities* produced, inasmuch as two *equal* forces would produce different velocities if one were allowed to act longer than the other.

Bearing carefully in mind, then, that the only way in which we can compare one *force* with *another*, is by observing the *different effects* produced (viz., difference of velocity produced, mass moved, time employed, &c.) under *precisely similar conditions* by the two forces, we shall see clearly what is meant by the "measure of a force," and understand how we

Digitized by Google

may have different measures for the same force (*i. e.*, different in their *nature*, not in their degree), according as we select one or other of the various *effects* produced, by which to measure it. For example, the force of the earth's attraction may be measured, either by the velocity which it produces in a certain mass after it has acted upon it during one second (which quantity, estimated in feet per second, is that usually denoted by the letter g (g being $=32{\cdot}2$ nearly), or by the *pressure* which this mass would exert against any obstacle which prevents it from moving. Now, "velocity" and "pressure" are of a totally different nature, and therefore cannot be compared with each other; but if we wished to compare *two forces*, we might select either of these two effects, and compare the *pressure* produced in a body by the one force, with the *pressure* produced in the same body (all the circumstances being supposed the same in the two cases) by the other force; or we might compare the *velocity* produced in one second by one force, with the *velocity* produced by the other in the same time. The beginner requires to be continually reminded of this, simple as it is, namely, that the quantities he meets with in works on the subject, do not and cannot possibly represent the *forces themselves* (the attraction, for instance, of the earth, &c.); but are nothing more or less than *numbers* or *ratios* which denote the *proportion* which the velocity produced by one bears to that produced by another, or which the *pressure* produced by one bears to that produced by another. To say, then, as some have done—and others still more strangely have argued about—that the velocity produced is proportional to the force, is mere tautology, if anything else beyond mere definition is intended.

What are termed the laws of motion are nothing more than the statement of certain self-evident truths concerning force in the abstract—which are necessary as the foundation of a system of mathematical deductions; but before we can *apply* any one of our results to any *actual* case in nature, we must know *what the forces acting are*. The first "law" is, "that a body, if unacted upon by any force, will persevere in the

Digitized by Google

same direction, and with the same velocity for ever." This is the same thing as saying, that if the body *does* change its direction or velocity, some *force* has acted upon it, and this force is capable of being measured. The second law is, that "if several forces act on a body, *each* will produce the same effect as if it acted alone. This law is not given by any two authors in exactly the same terms; the real signification, however, is merely that, if we have any force acting on a body, the presence of other forces does not modify the *force* we are considering: of course, they will modify the *effects* (*i. e.*, the velocity, &c.) of the original force, but will not affect the energy of the force itself.

Considered abstractedly this assertion, that the presence of a new force will not in any way affect the nature and energy of the other force is a mere postulation; which is absolutely necessary, however, before we could take a single step towards calculating the final effect resulting from all the forces. For, if the introduction of fresh forces altered the amount of the others, we should require to know in what way and to what degree such alteration took place. Considered as a physical law, it is altogether untrue in thousands of cases. For instance, a particle of oxygen will attract a particle of iron, but the presence of a particle of carbon, which also would attract the iron, modifies the force exerted by the oxygen. Those experiments which are usually cited in books to prove that this "law" is true, must either be intended to prove it true in every case of physical action, or else are mere illustrations of the meaning of the law. For example, the experiment of a pendulum vibrating in the same time in every azimuth proves simply that the earth's attraction is not altered by its rotation; and so for other such experiments. As a theoretical principle it is nothing else than a "postulate" necessary to be granted before any steps can be taken in the calculation—and as applied to what actually occurs in nature—it is absolutely necessary in every case to know before hand whether the acting forces do or do not influence each other's energies. If not, we can then find the separate effect produced by each, and

Digitized by Google

combining these, determine the final result. As an example, we may take the case of a ball struck at the same time by two different blows in different directions; it is obvious here, that one blow does not influence the *energy* of the other blow, or the *direction* in which it is given; hence the "law" is applicable here, and the resultant motion determined by combining the separate effects of the two blows.

The third law of motion has reference to the *quantity of matter* put in motion by a force. As we have before stated, a force may be *measured* by *any* of its *effects*, either by the *velocity* produced in a given time when the body is free to move, or by the *pressure* produced when motion is prevented by the presence of an obstacle. Suppose a man to pull a mass whose weight is a thousand pounds, and by pulling to give it a velocity; if by pulling uniformly for one second he can give this mass a velocity of 10 feet per second (which 10 feet per second is what is denominated the *Accelerating Force*, in this case), it is obvious, that if he had to exert the same "pull" on another mass weighing *two* thousand pounds, after pulling for one second he would only give it a velocity of *five* feet per second. Taking it for granted, for the present, that weight varies, or is proportional to the *quantity of matter*, we see that the *same force* when employed on *different masses* produces in the same time, *velocities* as much *less* as the *masses* are *greater*. Again; suppose that a man by pulling at a mass weighing one pound for the space of one second, it gives a velocity of ten feet per second, and another equal mass being added to the former, and he gives to this one also by pulling for one second the same velocity as the former—if now an obstacle be placed in the way of the mass of matter (weighing 2 lbs.) the *pressure* against this obstacle will be double what it would be when the mass acted upon was only one of the masses (in all these illustrations the masses are supposed to lie on a horizontal plane, and the string by which the pull is made to be also horizontal, so that the *weight* of the bodies does not affect the question in any other way than as being indicative of the *quantity of matter* moved.) If the pressure ex-

Digitized by Google

erted by the single mass, *tending* to go on with a certain velocity, be 10 lbs., that exerted by the double mass, *tending* to go on with *the same* velocity, will be twenty pounds. The velocity which would be produced in a body, if the force acted on it uniformly be for one second, is the "*accelerating force.*" This being the same for the two masses in the case supposed, we see that the *pressure* is *proportional* to the *mass* or *quantity of matter* moved when the "Accelerating Force" remains the same. Again: let the pressure exerted against an obstacle by the mass in the preceding case be as before ten pounds; if the man increase his pull, so as that, if free, the mass would at the end of the pull, (lasting one second as before) have a velocity of *twenty* feet per second, *i. e.*, double the former,—then it is equally obvious that the *pressure* will also be *doubled.* The accelerating force being, as we have said, the velocity produced in one second, the *accelerating force* being *doubled,* and the mass, or quantity of matter moved, remaining the same, we see that the *pressure* is doubled. Hence, if, the accelerating force remaining the same, we increase the *mass* in any ratio, just in the same ratio do we increase the *pressure* which would be exerted against any obstacle stopping the body; or, if we increase the *accelerating force* in any ratio, leaving the *mass* acted upon unaltered, just in *the same ratio* do we increase the pressure. Therefore, if *both* the *mass moved* and the *accelerating force* be *doubled,* the *pressure* will be *quadrupled,* and so on; in short, the pressure varies as the product of the mass moved and the accelerating force—which is the third law of motion. If P denote the pressure, M the mass moved, and *f* the accelerating force, then P is always *proportional* to M *f*. These principles, or laws of motion, are sufficient (with the aid of Geometry and the differential and integral calculus) for determining the motion of any particle of matter or rigid body when all the forces acting upon it are known. But the only forces which are generally given in any *problem* are the "external" ones; such, as for instance, the pressure on the piston of a steam engine; there being an unknown process going on in the interior of bodies by which the external

Digitized by Google

forces are transmitted and modified, and which process we know scarcely anything about. So long as we are treating only of the motion of "points," or of bodies, considered as mere particles, the motion of the various parts of the body amongst each other being neglected—we have no need of any further principles than those named. But when we take a solid body, and consider, not only its motion as a whole, but that of its various parts, seeing that the interior mechanism is unknown to us, we must devise some means of doing without it. For example, the planets are so distant from us, that the only part of their movements with which we are at all concerned, is that large and visible motion by which we see them change their places in the heavens. The attraction of the sun and other planets produces besides this an infinite number of other motions, such as revolutions round their axis, tides in their oceans, &c. &c.; but to these *minutiæ*, for such they are to us, we pay no attention whilst engaged in tracing out their orbits round the sun. Hence, the great mass of physical astronomy is altogether unencumbered with the consideration of those unknown forces, which render all the more familiar phenomena of our daily experience so difficult to calculate. Each planet is considered as a mere point (wherein, however, the whole quantity of matter of which the planet consists is supposed to be condensed), on which a number of forces are acting the magnitude and direction of each being known. It is a comparatively easy task to determine the resultant motion, therefore, in this case; and hence, physical astronomy, though dealing with a most sublime subject, is nevertheless a much easier and more certain science than the mechanics of engineers or every day life.

Amongst these subsidiary considerations which enable us to calculate the motion of any body or system of bodies, whilst ignorant of the exact mode in which force is transmitted from one part of the body to another, or from one body in the system to another; the most important are those relating to the centre of gravity, or, to give it its more general name, the centre of parallel forces. In every body, or system

Digitized by Google

of bodies, any how connected together, there is a point which may be taken as the representative of the whole body or system when we are considering the motion *as a whole*, and which also assists us very much when considering the motion of the parts amongst each other; for with regard to the first question, this point moves precisely in the same way as if the whole system or body were condensed into that point, and all the forces, instead of being scattered over the various parts, were each brought to act immediately on this point, each retaining its original direction and magnitude. Now the motion of a point is always easy enough to determine, and therefore the motion of the centre of gravity is also easily found. With regard to the second question: the motion of the various parts amongst each other, or the general motion of rotation is exactly the same as if this point, the centre of gravity namely, were *fixed*. To these two theorems reference is sometimes made under the name of "The Independence of the Motion of Translation and Rotation,"—that is, the general onward motion of the whole does not interfere with the rotation of the system which takes place round the centre of gravity, as if that point were absolutely at rest instead of moving onwards with the rest. As this theorem is perhaps the most important of the auxiliary principles in mechanics, and, moreover, admits of a very easy proof, I shall proceed to give it. It must be recollected, that the centre of gravity, or of parallel forces, is that point at which a single force, whose magnitude equals the sum of all the parallel forces, and whose direction is the same as theirs, must be applied in order to counterbalance them (if applied in the opposite direction to theirs,) or if applied in the same direction will be in every respect equivalent to them; so that they might all be removed without altering the body's motion or state, provided this one were left to represent them. Thus, if P, Q, R, S, T, (Plate 70, Fig. 1) be forces acting on a rigid body, and G be the point called the centre of these parallel forces; then, if a force equal to P+Q+R+S+T were applied in the direction G A it would exactly represent all the former forces;

Digitized by Google

or if applied just in the opposite direction, then it would just counteract all the others.

The centre of *gravity* of a body is the centre of all those parallel forces which the earth's attraction exerts on it; wherever there is a particle of matter there is one of these parallel forces; they are all considered parallel to each other, because they all meet in a point so distant, (viz., the centre of the earth), as to be to all perception parallel, and if the body be divided into particles of the same size the forces will also all be equal. It should not be forgotten, however, that the centre of *gravity*, is only a particular case of the general one where the forces are any whatever, and not the attraction of the earth alone. Suppose now any body be in motion, no matter in what shape the body may be, or what the nature of the motion. The centre of gravity, as part of the body is moving onwards, and the body is moreover revolving and rotating in all sorts of ways. The forces which produce the motion may be either the pressures exerted by means of ropes attached to it, the attraction of a number of magnets, or anything whatever, we shall obviously simplify the calculation of the motion, if we can reduce the question into the consideration of the two others, namely, first find what will be the motion of the centre of gravity, and then what will be the motion *round* that point. Now, any force applied to this point, is by the very nature of the centre of gravity, equivalent in all respects, and produces exactly the same motion, as a number of forces equal and parallel to each other, and applied to each particle of the moving body or system, their common direction being parallel to that of the force which we suppose to be applied to the centre of gravity, and their whole sum equal to that force. Since then, if these forces be so applied every particle would tend to move with the *same velocity* (because the forces are all *equal*), and in the *same direction* (because the forces are all *parallel*). None can interfere with the motion of another in any way whatever, any more than if they were all perfectly unconnected. Hence, by applying such a force to the centre of gravity as will bring it to rest,

Digitized by Google

we do not alter the *motion of rotation* round that centre at all, if there be such a rotation. Hence, we may always suppose the centre of gravity of a moving body to be at rest without altering the motion of rotation. This *simple* consideration will be found to *simplify* all problems wonderfully.

If any other point different from the centre of gravity had been taken and a force applied to it, this would not produce the *same* effect on *all* the particles. It is indeed capable of being replaced by a series of forces parallel to it, each of which is applied to its own particle, but these will not be *equal* to one another, and therefore the motion of one will interfere with that of another, whose tendency may be (on account of the *greater* force applied to it) to move *faster* (or slower).

Suppose G. (Plate 70, Fig. 2) to be the centre of gravity, and a force P to act at any point A. Apply at B (G B = G A) two forces, each equal to $\frac{1}{2}$ P, and parallel to it, in opposite directions. The application of these new forces will not in any way alter the previous state of the body. Then the $\frac{1}{2}$ P at A together with the $\frac{1}{2}$ P at B, which acts in the same direction, are together equivalent to P at G, *i. e.*, to their sum acting in the same direction, and there remains the "couple" ($\frac{1}{2}$ P—$\frac{1}{2}$ P) whose arm is run, or whose moment = $\frac{1}{2}$ P × run = P × G m; and this is the only part of the forces which influences the *rotation* since the force at G, by what has been previously said, does not at all affect it.

If it be asked, *why* choose $\frac{1}{2}$ P instead of P or any other force, as that which we apply at B; the answer is, that if P for instance, had been chosen, and two parallel forces, each equal to P, had been applied at B in opposite directions, then the P at B and the P at A would compound a force = 2 P at G, and *leave a force P at B* without anything at A to counteract its influence on the motion of translation. For the same reason G B is taken = G A, because otherwise the resultant of the parallel forces would not act a G, but at some other point, so as to affect the motion of rotation.

Hence the action of any force P affects the motion of the

Digitized by Google

centre of gravity, just the same as if it were acting immediately at that point, and affects the motion of rotation just the same as if the centre of gravity were fixed.

An example or two will illustrate this principle: let A B, (Plate 70, Fig. 3) be the keel of a steam-boat, or any other kind of vessel. The action of the paddle wheels is such by their position, that the resistance of the water always acts in lines parallel to the keel; the centre of gravity G moves on as if the whole of this force were applied directly to it in a line parallel to the keel. Suppose the rudder to be put in the position A R, the water impinging against it turns the boat round G in *exactly the same way as if G were a fixed point*; so that in the position of the rudder A R, the boat's head is turned in the direction of the arrow. The rudder therefore is put on that side towards which you wish the boat's head to go. Neither of these two motions would interfere with the others; but the boat goes on, and the point G describes the same path as before, were it not that by this turning round of the boat the *direction* of the moving force is altered—since the resistance of the water is always parallel to the keel. In the same way in a sailing ship, the alteration of the position of the rudder causes the ship to revolve round its centre of gravity, and thus presenting the sails at a different angle to the wind, the direction of the moving force is altered, and also the magnitude. In the proof of the preceding principle it must be remembered that the direction and magnitude of all the acting forces are supposed to remain the same—in cases such as this, therefore, where the direction, and also the amount of the forces, are *continually varying*, we require the application of the principles of the differential and integral calculus—which are not required when the forces are *constant* in magnitude and direction. But the *mechanical* principles required in the investigation are the same in both cases, and this separation of the more complicated motions into their constituent parts, by which we are enabled to calculate separately the effect of each, and then afterwards by combining them, find the result—is a very valuable aid, without which, indeed

Digitized by Google

very few problems could be solved. The next example we shall take will be the locomotive.

In the locomotive the only external force (besides the resistance of the air) is the friction which enables the wheel to lay hold of the rail, and by an action precisely the same as that of a cog-wheel and rack (only that the teeth of the wheel and rail are invisible from their minuteness), sends the engine on, because the rail is fixed (if the engine were fixed and the rail moveable, it would be the rail that would be sent backwards, just in the same way as the engine is now sent forwards). The centre of gravity of the engine will therefore move in the same way as if this force were immediately applied to it. The motion of the various parts of the engine *amongst each other* can in no way affect the motion of the centre of gravity; they are of course necessary in order to produce the revolution of the wheels, and by their friction against the rails to obtain the *external* force; but of themselves they are entirely without influence on the progressive motion of the engine.

The fact that it is utterly impossible for any motion amongst the various parts of any machine to produce a motion of the centre of gravity—except in so far as this internal movement calls into play some force *external* to the machine—has been forgotten by many projectors, although all have not exhibited it in quite so barefaced a light as the worthy who proposed to propel a boat by simply erecting a large bellows near the stern and blazing away at a board placed there. If he had been content with puffing away at "empty air," he would have got on better; for he would then have called into play an external force, namely, the resistance, such as it is, of the particles of air to the impinging current from his bellows—and the re-action would have all been available, just as in the rocket.

This principle of the independence of the motions of rotation and translation being, as I have said, one of the most important and useful in mechanics, it is worthwhile to consider all the circumstances connected with it.

Digitized by Google

on
of
he
nt
at
ic-
v-
ne
is.
ic-
B,
C,
ed.
the
the
the
the
ci-
by
see
the
int,
B
rin-
&c.,
and
rec-
ody
der-
ame
ring
not
s we
lus).
ain-

Digitized by Google

ve
tal

sis
la
th
an
gi
an
ba
fo
for
ap
an
tre
du
ag
sel
mo

the
cer
cal
for
it i
to
ste
bee
hav
an
par
and
the

T
tion
imp
side

Digitized by Google

And, in the first place, since the effect of any force P, on the motion of rotation depends on the distance of its point of application from the centre of gravity, whilst its effect on the motion of the centre of gravity is the same at whatever point of the body P be applied, it would appear at first sight that there is a *gain* of *force* or a general increase of effect produced according as the point of P's application is further removed from the centre of gravity. But the consideration of one simple case will suffice to show the erroneousness of this. Suppose A B (Plate 70, Fig. 4) to be a rod, which by the action of some force applied to it at a point beyond G and B, transfers it into the position C D; the angle D G B, or A′ G C, will be greater the further from G the force has been applied. Now, if the same force had been applied directly at G, the middle, or centre of gravity, of the rod, and had acted for the same time, it would have carried it parallel to itself into the position A′ B′. If, therefore, we take as the measure of the force the quantity of matter moved, multiplied by the velocity with which it is moved (or, which is the same thing, by the space over which it is moved in a given time), we see that the effects of the force, measured in this way, are the same, whether it has been applied at G or at any other point, inasmuch as they are represented by the equal areas A C B D, AA′ BB′.

The following is another method of considering the principle;

Suppose any number of bodies, or points, A, B, C, D, &c., (Plate 70, Fig. 5) perfectly unconnected with each other and free to move any how, are moving along certain fixed directions, as in the figure, with any velocities; since each body moves in a constant direction during the time we are considering, the direction of the force acting upon it remains the same during this time, and may also be considered *uniform* during this time (for as the time during which the forces act does not at all affect our present question; we may take it as small as we please, and apply the reasoning of the differential calculus). Therefore the general resultant of all the forces will main-

Digitized by Google

tain a constant direction and magnitude during the time, as also will the resultant moment or "couple" (these two quantities being determined as if A B C D, &c., constituted a solid system). Now suppose all these separate bodies A, B, C, D, &c., to become suddenly connected together, so as now to form one rigid system. The motion of each individual body or particle will now be altered, in consequence of its connection with the rest, and in order to determine the subsequent motion of each we must take into account all the fresh forces thus introduced. For instance, if A become connected with B by a rigid rod, at the instant of connection, there arises a tension, or pressure, in this rod. Call it T; then, in addition to the force (P) which before acted on A, we must consider T; and so on for every other point. But T acts on B as well as on A, only in the opposite direction. Hence, in forming the general resultant of all these *new* forces, for every term (+T) there will be another (—T), so that the resultant of all this newly introduced force, as well as their resultant couple, or moment, is reduced to zero. Therefore the resultant of *all* the forces, originally acting and newly introduced, remains the same as before. If the direction of the resultant were that represented in direction and magnitude by the line R in the figure, *before* the connection, it will also be their resultant *after* that connection. Provided, therefore, the *external* forces, acting on any system of particles or bodies, remain the same, the motion of the centre of gravity, and the rotation round that centre, will remain unaltered, whatever be the action of any one part of the system on another by means of any *mutual* forces, such as that of rods, &c. The preceding is similar to Poinsot's mode of considering the question in his Memoire surla Composition des Mouvements, &c.; but he supposes the *velocities* of each of the points A, B, C, &c., before connection, to be *uniform*, and says, that therefore the "force which animates it remains constant:" it is better, however, I think, to consider the forces *acting* on A, &c., rather than the momenta *animating* them—and if the velocity be uniform, the force *acting* is zero. The

Digitized by Google

theorems called—"The Conservation of the motion of the Centre of Gravity," and "The Conservation of Areas," are merely the expression of the results just obtained in an analytical form adapted to calculation—or, rather, I should say, the latter of these theorems is such.

There is another theorem of great practical use, which has received the name of the "*principle* of Vis Viva," which differs however from the preceding principle, inasmuch as it is merely *a very useful equation or relation* amongst the various effects of the forces; whereas the other is a general principle, strictly so called; both, however, are of the greatest use in simplifying problems.

As this principle or equation of Vis Viva is of great importance in a practical point of view in the calculation of the "work done" by machines, I shall take up the subject from the beginning, assuming only the equations of motion. In most works, the investigation is founded on the principle of virtual velocities, which I consider to be very objectionable, as no proof of that principle has ever yet been given in which every body agrees; and, at any rate, not one student in a thousand ever reads such proofs as have been given. As moreover, there is not the slightest necessity or reason for any reference whatever to that principle, I think it far better to treat the subject independently. Suppose, then, m, m', m'', &c., to be a system of particles any how connected, and acted on by external as well as by mutual forces. Let *all* the forces acting on (m) be equivalent to X. Y. Z. acting along the co-ordinate axes. These forces, it must be recollected, are supposed to include the tensions, mutual pressures, and, in short all the mutual actions of the other particles, as well as the given external ones.

$$\therefore \frac{d^2x}{dt^2} = X \quad \frac{d^2y}{dt^2} = Y \quad \frac{d^2z}{dt^2} = Z.$$

$$\therefore 2\frac{dx}{dt}.\frac{d^2x}{dt^2} + 2.\frac{dy}{dt}.\frac{d^2y}{dt^2} + 2.\frac{dz}{dt}.\frac{d^2z}{dt^2}$$

$$= 2.\ X.\frac{dx}{dt} + 2.\ Y.\frac{dy}{dt} + 2\ Z.\frac{dz}{dt}.$$

$$\therefore \left(\frac{dx}{dt}\right)^2 + \left(\frac{dy}{dt}\right)^2 + \left(\frac{dz}{dt}\right)^2 \text{ or } V^2 = 2.\int\left(X\frac{dx}{dt} + Y.\frac{dy}{dt} + Z.\frac{dz}{dt}\right)dt$$

$$= 2.\int(X dx + Y dy + Z\ dz)$$

$$\text{or } mv^2 = 2m.\int(X\ dx + Y\ dy + Z\ dz).$$

Digitized by Google

Similarly, if X′, Y′, Z′, represent the *whole* of the accelerating forces acting on (m'), then for its velocity (v') we should have $m' v'^2 = 2m' f (X' dx' + Y' dy' + Z' dz')$, and so on for all the particles. But it is obvious, that in these equations, as they stand, we have, or may have, a number of *unknown* forces, inasmuch as X, Y, Z, and X′, Y′, Z′ include the internal actions, of which we know nothing except that they are *mutual*. Fortunately this knowledge that they *are* "mutual" is enough to enable us to get rid of them: otherwise these equations first found would be of no earthly use. Suppose therefore, that in addition to the external forces—all of which are known—there is included the tension or mutual pressure of a rigid rod connecting *(m)* and *(m′)*, denote this pressure by P. Let this rod or line mm' make angles α, β, γ with the axes. Then, amongst the accelerating forces acting on (m), we have

$\frac{P}{m} \cos \alpha$ acting along axis of x and $\therefore$ included in the X,

$\frac{P}{m} \cos \beta$ ..... ditto ..... y and $\therefore$ ..... Y,

$\frac{P}{m} \cos \gamma$ ..... ditto ..... z and $\therefore$ ..... Z,

But the *pressure* on the other particle (m') exerted along mm' is equal to that on (m) which acts in exactly the opposite direction. So that if one be considered positive the other will be negative. Hence, amongst the forces X′, Y′, Z′ acting on (m), there will be

$-\frac{P}{m'} \cos \alpha$ acting along axis of x, and $\therefore$ included in the X′,

$-\frac{P}{m'} \cos \beta$ ..... y, and $\therefore$ ..... Y′,

$-\frac{P}{m'} \cos \gamma$ ..... z, and $\therefore$ ..... Z′,

Therefore in forming the sum of mv^2 and $m' v'^2$ on one side of the equation, the other namely,

$2 m' f (X' dx' + Y' dy' + Z' dz')$, we shall have, amongst the rest, the following terms:

$$2 \cdot m \cdot f \left(X \tfrac{P}{m} \cos \alpha \cdot d + x \tfrac{P}{m} \cos \beta \, d y + \tfrac{P}{m} \cos \gamma, dz\right)$$
$$+ 2 m' f \left(-\tfrac{P}{m'} \cos \alpha \cdot dx' + \tfrac{P}{m'} \cos \beta \cdot dy' + \tfrac{P}{m'} \cos \gamma \cdot dz'\right)$$
$$= 2 \cdot P \cdot f \cdot \cos \alpha \cdot (dx - dx') + \cos \beta (dy - dy') + \cos \gamma \, (dz - ') \Big\} \ldots (A).$$

Digitized by Google

Now, the distance between (m) and (m') remains constant, since they are rigidly connected call this distance r, then

$$r^2=(x-x')^2+(y-y')^2+(z-z')^2$$

$$\therefore r dr=(x-x')(dx-dx')+(y-y')(dy-dy')+(z-z')(dz-dz')$$

$$=r.\cos\alpha.(dx-dx')+r.\cos\beta(dy-dy')+r.\cos\gamma(dz-dz')$$

the first side=zero since $dr=o$, $\therefore$ the second also$=o$.

or $\cos\alpha(dx-dx')+\cos\beta(dy-dy')+\cos\gamma(dz-dz')=o$

Therefore, the sum or expression (A) vanishes. Hence the mutual pressure P entirely disappears from the final sum. The same evidently is true for all such actions between every two particles.

Therefore in the equation,

$$mv^2+m'v'^2+m''v''^2+\&c.=2mf(X\,dx+Y\,dy+Z\,dz)$$
$$+2m'f(X'dx'+Y'dy'+Z'\,dz')$$
$$+2m''.f(X''dx''+Y''dy''+Z''\,dz'')$$
$$+\&c.\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(B)$$

the second side of the equation contains *no unknown tensions* or *mutual pressures*. If instead of a rigid rod, (m) and (m') be connected by a *string*, the preceding reasoning will be precisely the same *if the string remain light and of the same length*, because then the distance (r) is constant, and $dr=o$, if, however, the string be extensible dr may not$=o$, and then we should have an unknown term P dr. If the particles be actually *in contact*, of course the preceding reasoning applies to their normal pressure, which is got rid of in the same way, and will not appear in the equation (B); again, let (m) and (m') mutually attract each other; the law of attraction being any function of the distance (r) may be denoted by $f(r)$.

The mutual force will be, therefore, $mm'.f(r)$, the direction being opposite for m and m'. Hence in forming the sum on the second side of equation (B) we should have

$$\cdot mm'f\left\{\cos\alpha(dx-dx')+\cos\beta,(dy-dy')+\cos\gamma(dz-dz)\right\}f(r).$$
$$=mm'f(r)\,dr.$$

[*Example.* Three particles $m\,m'm''$, at mutual distances $r_1\,r_2\,r_3$ attracting each other according to inverse square of distance.

$$mv^2+m'v'^2+m''v''^2=-\mu\left(mm'.\tfrac{1}{r_1}+mm''.\tfrac{1}{r_2}+m'm''.\tfrac{1}{r_3}\right)+C.]$$

Digitized by Google

Again let there be impact between (m) and (m') during the motion, and suppose both perfectly elastic. Also let P=mutual pressure during contact at any instant. The direction of this normal force is supposed to remain the same during the contact. Then the action may be divided into two portions of equal duration, one (1) of compression, during which (r) the distance between them is continually diminishing and another (2) of expansion during which this distance is continually increasing, till it reaches its original amount. The term therefore $\int P dr$, which we have to take into account, is the same during these two periods but of contrary signs; therefore the sum=zero, and the term may be neglected. It will also be seen how the collision of imperfectly elastic bodies may be taken into account; but I shall now go on to the explanation of how this general equation is applied in calculating the *work done* by any machine. The equation is generally written thus:

$$\Sigma . mv^2 = 2\Sigma . mf (Xdx + Ydy + Zdz)$$

the symbol (Σ) denoting the *sum* of all such terms as that to which it is prefixed: for instance, the second side is equivalent to

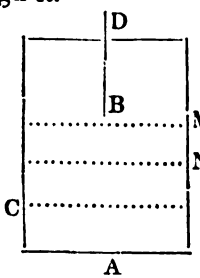
$$2mf (Ydx + Ydy + Zdz) + 2m'f ('Xdx' + Y'dy' + Z'dz') + \&c.$$

X, Y, Z being the *accelerating* forces which act on the particle whose mass is (m), and whose co-ordinates are x, y, z.

Now it will depend entirely on the student's knowledge of the *principles* of the integral calculus, whether he will be able to attach any definite *physical* meaning to the second side of this equation, or whether he will see nothing but a mere piece of algebraic work to be performed. In the first place, then, it must be remembered—and, indeed, ought never to be forgotten in any physical problem—that an "*integral*" is a "*sum*", and moreover [which is very seldom attended to] that in the expression $\int P dx$ the factor [dx] is not by any means to be omitted in *forming that sum*. As, however, we are not explaining the differential and integral calculus, a thorough acquaintance with its application to physics is taken for granted; the use to which the preceding integrals will be put, af-

Digitized by Google

fording us a good illustration of all such applications. The *work done* by a machine is conveniently *measured* by the number of pounds raised one foot high—or generally by $P \times S$, P denoting the pressure overcome through a space S by the machine. Hence we see how conveniently the preceding formula is adapted to the purpose of calculating such work, involving as it does on one side the sum of such terms a Pdx, P denoting a pressure, and (dx) the space through which it is moved. This use will best be seen by taking an actual case and going through it.



Suppose steam to be admitted into the cylinder AD at a until it occupies the space AC, the whole pressure on the piston at any instant being $=P$ pounds, the steam being of the same pressure as in the boiler from which it comes. If the distance from A to $C=(a)$ feet, the "*work done*" through this extent of motion will be expressed by $P \times a$; and if the communication with the boiler were kept open during the whole stroke of the piston the total amount of work done in moving the piston from A to D (there being no pressure supposed on the top of the piston or any other resistance to the force of the steam) would be $=P+AD$. But suppose the communication with the boiler to be cut of at C and the remainder of the stroke left to be accomplished by the expansion of the steam in AC, from this point therefore up to the top, we have a continually varying force which is not the same for any two positions of the piston or for any time however minute and inappreciable. It is obvious that we can no longer estimate the work done after leaving C in the same way as we did just now whilst the pressure remained

Digitized by Google

the same from A to C. It is here that the integral calculus becomes absolutely necessary, and by considering the nature of the difficulty in the present case, a person who is ignorant of this part of mathematics, may form some notion of the invaluable aid it affords in all branches of physical inquiry. Indeed it may be safely asserted that the progress of Astronomy and all other parts of Experimental Science to which Mathematics are applicable is almost entirely dependant on this branch of it—and that without a thorough *understanding of its principles* (the differential and integral being here considered as the same subject) no student however expert he may be in "integrating" and performing algebraical tricks, can ever make any real progress in these inquiries.

In making this observation I am deviating from the question before us, but I take this opportunity of assuring the learner that no time or labour should be grudged in obtaining a clear, downright, unmystified insight into this subject, as he may take it for granted that he can never by any possibility do any thing without it, let the distance from the bottom of the cylinder to N=x and NM=ax. The pressure of steam being inversely as the space occupied we have the pressure on the piston at N=P. $\frac{a}{x}$. By the principles of the differential calculus we may suppose this pressure to remain unaltered whilst the piston moves from N to M: therefore on this supposition, the work done from N to M=P. $\frac{a}{x}$, dx, and the whole work done from C up to D=f P $\frac{a}{x}$ dx, between the limits x=AD=b, suppose, and x=a, and this integral or sum P. a ($\log_\varepsilon b - \log_\varepsilon a$). Now this expresses that the work done from C to D is equivalent to the *number of pounds* denoted by Pa ($\log_\varepsilon b - \log_\varepsilon a$) raised *one* foot. For instance, let P = 1000 lb. (a) = one foot and (b) = 10 feet, then Pa (. $\log_\varepsilon b - \log_\varepsilon a$) = 1000 × $\log_\varepsilon$ 10 = 1000 × 2.3026= 2302. So that in this case the work done in expanding through 9 feet would be equivalent to 2302 lbs. raised one foot (neglecting very small decimals).

As $Q_1 \times S_1 + Q_2 \times S_2$ + &c., or in other terms to the

Digitized by Google

sum of all the pressures or weights each multiplied by the space over which it has been moved. So that, if we like, we may say that the work done is P lbs. moved through a ($\log_\epsilon b - \log_\epsilon a$) feet, or P a pounds raised through ($\log_\epsilon b - \log_\epsilon a$) feet, or lastly, as we took it at first, P a ($\log_\epsilon b - \log_\epsilon a$) pounds raised *one* foot.

If the integral $\int P dx$ be considered in a somewhat different light, namely, as expressing the "sum of all the values of P between the given limits," the interpretation is still the same as before, inasmuch as the product P × S may just as well be considered to mean "the sum of all the pressures through space S" as the product of the number of units in P by the number of units in S; *provided however*, that every where P be taken to denote the *instantaneous* pressure, *i. e.* that which does not last any finite time. In fact it is evident that the product of the pressure exerted by the *time* (or rather the product of the *units* in each) during which it is exerted, may just as well be taken as the measure of the work done, as the product of the pressure and *space*—just as well, I say, except for convenience: as however in all actual cases of the motion of machines, the spaces passed over are much more convenient to measure than the time employed—(which latter element indeed could seldom be used at all for numberless reasons) the choice of course falls on "space" rather than on "time" as a more easily manageable and measureable element. There are cases however in which the latter would be preferable.

The "work done" if the steam had not been cut off would have been 1000 × 9 or 9000 lbs. raised one foot. So that the loss of power due to this cutting off at $\frac{1}{10}$ of the stroke=6698lbs. raised one foot. And of course in the same way any other question as to the effect produced by cutting off the steam at any part of the stroke might be answered. But as it may not be immediately obvious to some that the expression given by integrating, really means what we have said, it may be as well to enter into the reasons rather more fully. Suppose therefore the piston to move by successive starts from one position to another, just as from N to M, each of these suc-

Digitized by Google

cessive spaces passed over being $=dx$, and the pressures at the different stages to be denoted by P_1, P_2, P_3, &c. Then, obviously, the whole "work done" is expressed by the sum $P_1\,dx+P_2\,dx+P_3\,dx+$&c.

Now in estimating the "work done," it matters not whether the whole pressure or weight be raised at once through any given space or divided into separate portions each of which is raised or the resistance overcome through a certain space, *provided* the whole product of the pressures by their respective spaces remain the same for both cases. Thus if a weight Q be raised through a space S, and we take $Q_1\times S_1+Q_2\times S_2+Q_3\times S_3\times$&c.$=Q\times S$ the work done will also be equal to Q_1lb. raised S_1 feet + Q lbs. raised S_2 feet + Q_2lbs. raised S_3 feet + &c. Hence the integral or expression Pa $(\log_\epsilon b-\log_\epsilon a)$ being in reality, the *sum* P_1dx+P_2dx+&c. is equivalent to such a series. The form in which we have left equation (B), is not immediately applicable to our purpose—inasmuch as it involves *masses* and *accelerating forces*, whereas what we have given in actual cases are *weights* and *pressures*. The necessary transformation is easily made. Let *w* be the weight of the body whose mass we have denoted by *(m)*, and so on for the others. Also let P be the *pressure* produced by the accelerating force X in this body. Then by the third law of motion, the pressures produced in the same mass are proportional to the accelerating forces corresponding to them; hence *(g)* being the accelerating force of gravity, we have,

$$X : g :: P : w, \text{ or } X=g,\ \frac{P}{w}$$

Hence in such an expression as

$$m\,v^2=m\int X\,dx$$

we may write instead

$$\left(\frac{W}{g}\right)v^2=\int P\,dx.$$

It is also easily shown that if P be the pressure produced by the three rectangular accelerating forces X, Y, Z, on the mass *(m)* and *(ds)* be the space through which *(m)* moves in the same time that *(dx)*, *(dy)*, *(dz)*, are described along the

Digitized by Google

axes, then $Pds = m\,(Xdx + Ydy + Zdz)$. So that the equation of vis viva for practical applications may be written

$$\left(\frac{W}{g}\right)v + {}^{2}\left(\frac{W}{g}\right)v^{12} + \left(\frac{W^{11}}{}\right)v^{12} + \&c.$$
$$= 2f\,Pds + 2f\,P'ds' + 2f\,P''ds'' + \&c.$$

The second side of this equation expresses the sum, or general amount of "work done" by each pressure. In every machine the whole of the pressures may be classed under three divisions; (1) the pressures at the part of the machine nearest the source of power, as the pressure on the piston of a steam engine; (2) the resistance or pressures to be overcome, as the weight of the uplifted water in a pumping Engine or the resistance at the crank and fly wheel in Rotary Engines; (3) the various sorts of friction and other impediments to the transmission of the motion from one part of the machine to the other.

So that the whole of the pressures operating on all the parts of the machine may be included and made, to enter the equation of vis viva under the following form.

$$\Sigma\,(Ppd) - \Sigma\,(Rdr) - \Sigma\,(Fdf)$$

the symbol Σ denotes as before the sum of all such terms as that to which it is prefixed, and which of course can only be actually written down at full length for each particular machine. Pdp represents the work done by the *useful* pressures, or those at the parts of the machine which *receive* the moving power in the first place. Rdr the work done by the various resistances, the very objects for which the machine is used, and Faf is the work done in overcoming the *useless* resistances such as friction. The negative sign is of course prefixed to these latter quantities because they are evidently *opposed* to the first. The first side of the equation contains only quantities which are very easily measured, viz., weights and velocities; hence, if this first side be calculated for any given machine, and the first two terms on the second side be also calculated, the difference between the two results represents the *waste of power*, viz. that expressed by $\Sigma\,(Fdf)$ or the force expended uselessly and without any return for

Digitized by Google

it. Let us take, as an example, a pumping engine, where the resistance at the working end of the beam is always the same, and the work done by it is equal to the weight of water raised through a given space. Call this quantity W″, and the work done by the piston during the same time W′, this being determined as in the case at the beginning of this article—taking care, of course, to allow for the weight of the atmosphere, &c., in the value assigned to P. If, also, the *useless* work done be called U, the second side of the equation of vis viva is W′—W″—U. The velocity of the piston (supposed with its rod to move vertically as one body) being denoted by (N), that of the mass of water at the other end of the engine will also be (*v*). The only other moving part is the beam. If (ω) be the angular velocity of this at the same time as that to which all the above quantities are referred, the linear velocity of any particle of it at a distance (γ) from the centre= $\gamma\omega$ and the sum of all the elements or particles each multiplied by the square of its velocity $=\Sigma m\gamma^2\omega^2=\omega^2 . Mk^2$ Mk^2 being the moment of inertia round the centre of the beam. The weight of the piston and its rod being Q *lbs.* that of the pump-rods Q′ and of the beam R, also neglecting the weights of the air pump rods, &c., and including their prejudicial resistances in the sum U, we have, as the equation in this case (the weight of the water being W)

$$\frac{Q}{g}v^2+\frac{R}{g}k^2.\omega^2.+\left(\frac{W+Q'}{g}\right)v^2=W'-W''-U.$$

Hence if it is wished, U or the *waste of power* is known, since all the other quantities are known, and it is obvious that many other questions as to the velocities, &c., are also easily answered by a simple inspection of this formula. It must be remembered that in it all the quantities are reckoned from a state of rest, or that the velocities are nothing when the work done is nothing. It is better perhaps, to put the first side into the form.

$$\frac{Q}{g}(v^2-v'^2)+\frac{R}{g}k^2(\omega^2-\omega'^2+\frac{W+Q'}{g}(v^2-v'^2).$$

v' and ω' being corresponding velocities at some other known time and let the quantities on the second side denote the

Digitized by Google

work done *since that time*. In the common form of the steam engine, where the crank and fly-wheel are used, the connection between the various velocities is so much more complicated and leads to such long and harassing calculations, that it is not at all a pleasant thing to enter upon; those who choose to do so, however, may find something to suit them, and perhaps save them some labour, by referring to the 21st "Cabier" of the *Journal de l'Ecole Polytechnique*, where there is a very laborious paper by M. Coriolis —"Sur l' influence du moment d' inertie du balancier d'une machine á vapeur, &c."

Although it has been thought better to give an independent proof of the equation of vis viva, rather than found it on that of virtual velocities, the connexion between the two is so great that one may be easily derived from the other.

The following is one way amongst others by which we may derive the equation of virtual velocities from that of vis viva.

It must be remembered that, in the equation $mv^2+m'v'^2+m''v''^2+\&c.=2(\int P dp+\int P' dp'+\int P'' dp''+\&c.)$ the velocities v, v', &c., are the velocities generated since the instant that the forces P, P′, P″, &c., began to act upon the system: care must be taken therefore with regard to the limits of integration on the second side, so that if at any given instant the velocities be (v_1), (v'_1), &c., and the corresponding forces P_1, P'_1, &c., and at another instant afterwards the corresponding quantities be (v_2), (v_2'), &c., P_2, P_2', &c., the equation will be

$$m(v_2^2-v_1^2+m'(v'^2_2-v'^2_1)+\&c.,=2\left(\int_{P_1}^{P_2} P dp+\int_{P_1'}^{P_2'} P' dp'+\&c.\right)$$

suppose now any system of rigidly connected particles to be in motion, and that the first of the preceding equations expresses the relation between the velocities of the different points and the forces which have acted upon them up to that instant, at which the values of those forces are P, P′, &c. During the next instant the increment of velocity and force will be expressed by the relation,

$$m(v.\,dv)+m'.(v'\,dv')+\&c.=P dp+P' dp'+\&c.,$$

Digitized by Google

where (dp) is the space described by the points of application of P in its own direction; and so of the rest.

Now suppose that at the beginning of the instant we are considering, the various acting forces are so related that from that moment the velocities (v), (v'), &c., become *uniform*: the motion of the whole system therefore at this instant is perfectly unaltered by the forces then acting on it: in other words, these forces are such that they mutually destroy each other's effect, and if the system were at rest, *would keep it at rest*. Hence at this instant we have, (since $dv=0$, $dv'=0$, &c., the velocities being at that instant uniform,)

$$0=P\,dp+P'dp'+\text{ &c.}$$

which is the equation of virtual velocities.

If at the instant we are considering the whole vis viva is a maximum or minimum (*i. e.*, as depending on the forces), in either case $dv=0$, $dv'=0$, &c., and the position at that moment is one in which the forces tend to keep the system at rest. "It is usual to distinguish between these cases as positions of stable or unstable equilibrium; but I suspect there is a fallacy in the reasoning, and, at any rate, we can only conclude anything for displacement of the system which *actually* occur in the motion itself: so that we are not authorized in supposing these to be the same as the ordinary *statical* positions of stable or unstable equilibrium. The question, however, is one of very little practical importance. It is also sometimes assumed that if the differential co-efficient of the whole vis viva is zero, the vis viva itself is a maximum or minimum. With regard to this, Professor De Morgan has remarked, in his *Differential and Integral Calculus*, that 'The assumption that A is a maximum or minimum when $d\,A=0$, has occasioned many errors, and the greatest writers have their full share of them.'"

By the proof given in a preceding article the equation of vis viva will be seen to be applicable to all motions of particles, during which the particles acting on one another *remain at the same distance*. It is therefore at once applicable to the motion

Digitized by Google

of incompressible fluids, and indeed was taken as the basis of the first Analytical Treatise on Hydronamics published—viz., that of Daniel Bernoulli.

His father John Bernoulli—(one of the most quarrelsome old men that ever lived, who was always squabbling with his brother James whilst he was alive, and with all and sundry afterwards) no sooner sees his son Daniel seizing hold and making use of this principle—(for which as being his mathematical progeny, he entertained still more affection than for his less abstract offspring) than with a sort of feeling of "no poaching on my manor, if you please," he bethinks himself how he is to avenge the injury. It will be seen that the old gentleman was in somewhat of a quandary for he could not deny the correctness of the principle, inasmuch as he himself had been its chief author and nourisher. And yet he was loath to admit that his son Daniel had made more of it than his father had managed to do. Still, to be outdone by Daniel would never do,—so he sets him to work and writes a new treatise on the same subject, and in the preface does his best to make you understand that whatever was good and true in Dan's book, as depending on this vis viva ("*verisimo atque a me demonstrato*") must be set down to the credit of the father —but at the same time that Daniel's method being an indirect one, and moreover as neglecting to take into account a certain "gurges" or "whirlpool" which he, the father, had discovered ("*ab aliis non animadversum*")—must altogether be a very inferior performance indeed to that with which he himself is about to favour you.

The old gentleman finds it easier however to get himself and his readers into this newly discovered whirlpool, than out of it again.

With regard to the motions of elastic media, the question as to the applicability of the equation of vis viva is more intricate, and at the same time of considerable importance. In all cases where two vibrating particles of the medium, contiguous to one another, undergo precisely the same motions, and at the end of any given time return to their original distance, the

Digitized by Google

equation evidently holds good, as the proof given above shows. For the action between them is equal and opposite and by supposition, the spaces through which it acts are the same for the two particles. But if we have, as in the undulating theory of light, to investigate what takes place at the confines of two different media, although we are certain that the mutual force is the same for both, we are by no means sure that the spaces through which that force acts are the same for both; and, moreover, the forces acting on the particle in the denser medium, are not the same as those on the particle in the rarer medium; so that, although they return to their original distance, one may have gone over a much greater space than the other. This is a question, however, which as yet has never been thoroughly examined.

The history of this vis viva is altogether curious. For a history of the dispute connected with it, which lasted about sixty years, and set almost every body in Europe scribbling about it, the reader may refer to *Whewell's Hist. Inductive Science*, vol. ii. Leibnitz commenced it by a paper in the *Act a Eruditorum* —" a short demonstration of a memorable error of Descartes and others concerning the natural law, by which they think that God always preserves the same quantity of motion; in which they pervert mechanics." The strange way in which the mathematicians of those days thought good to reason, or rather to write about the matter, is often not a little amusing. Even the best of them talk very queerly; for instance, John Bernoulli has a paper, *De Vera Notione Virium Vivarum*, in which he says, " vis viva does not consist in *actual exertion*, but in the *faculty* or *power of acting;* for it exists, even though it do not act, and has nothing to act upon." " Hence it appears," says he in another place, " that this vis viva is something *real and substantial*, which subsists per se, and as far as in it lies, is not dependent upon any body"—" quantum in se est non dependet ab alio." It would, therefore, appear to be a substantial, independent gentleman, " living on its means"—none of your flimsy mathematical abstractions. As I have said, every body had a hand in the dis-

Digitized by Google

pute—a French Marchioness amongst the rest, in a learned "Treatise on Fire." Voltaire, too, above all earthly men, must needs read a *Memoir* on the subject to the Academy. Now, what was all this dispute *about?* Why, if there *really* was any *real* dispute at all (which is rather doubtful, and always is, in such cases), the point in question was this:—Whether the magnitude of a force should be *measured* by the velocity generated (in a given mass) in *a certain time*, or by the velocity generated in moving through *a certain space*. If in the time *(t)* a force produced in a mass *(m)* a velocity *(v)*, then Newton had taken as the *measure* of that force the product $m\,v$; and those who considered themselves his partizans and defenders in the dispute alluded to, contending that this was the *only proper measure*. Leibnitz and his followers would have it that the only proper measure was the product $m\,v^2$ where *(v)* is the velocity produced or destroyed in moving through a given space *(s)*. This they confirmed by citing the following experiments:—Balls projected horizontally against a wall of clay, or other resisting substance, penetrated to depths proportional to the squares of their velocities (the masses being the same). Also, bodies projected upwards rise to heights proportional to the square of the velocity of projection. Now, the whole question is very easily decided by referring to those simple and self-evident principles by which we are necessarily guided in *estimating* or *measuring* any cause by certain of its effects. In comparing, therefore, one force with another, we are at perfect liberty to take *any* of the effects (as, for instance, the velocity produced) *provided all the rest of the circumstances are the same* in the two cases. The velocities produced, for example, will be correct measures of the force, provided they be produced in *equal times* in *equal masses*, all the other concomitant circumstances being also the same. Now, in the case of the balls fired upwards, or into the clay wall, this necessary condition of equality of circumstances was overlooked by most of the Leibnitzians, inasmuch as the ball which rose highest in the air, or sunk deepest in the clay, would take a *longer time* than the other. The one for instance being fired with a velocity *(v)*, and penetrating a space *(s)*, and the other with a

Digitized by Google

velocity (v') and penetrating a space (s'), if we denote by (f) the resisting force of the clay, or the retarding force of gravity, we have

$$v^2=2fs,\ v'^2=2fs'.\quad v=ft\quad v'=ft'.$$

(t) and (t') being the times of motion in the two cases. Hence it is seen that if the *space penetrated* be alone considered, and taken as the *measure* of the force, then the square of the velocity is proportional to that quantity; but if, as we evidently ought to do, the *time* be also taken into account, then, measuring the force by the space described, directly, and the time employed, inversely.

$$\frac{S}{s}=\frac{v}{2},\quad \frac{S'}{s'}=\frac{v'}{2}.$$

I have said "some of the Leibnitzians" seem to have forgotten this necessary precaution; but John Bernoulli was perfectly aware of it, only he contended that any force ought to be measured by the *whole* effect produced, without any reference to the circumstances under which it was produced, and uses the queer illustration that, in estimating the quantity of water in a basin, we never think of how long it would take to fill it. The answer is easy. Though, in *measuring any one force without reference to, or comparison with any other*, we may properly take the whole effect so produced; yet, in comparing with others, we must have all the circumstances the same; and, to use his illustration, though, in measuring the work done by a person in filling the basin with water, we might take the quantity of water put in as a measure, if we had to compare this with the work done by another person in filling another basin, we must take into account *how long* each person took to do it. Or, to use another illustration, a man might carry a ball of iron as far as a cannon could fire it; and so we might say the *whole effect* of the two was the same, or the whole force expended in each case the same; yet, obviously, for all ordinary purposes of comparison, we must consider not only the work done, but *the time in which* it is done,—not only the whole effect produced, but the time in which it is produced.

There has been a curious sort of "metempsychosis," or trans-

Digitized by Google

migration of ideas into different forms, in this subject, from "work done" to "vis viva" and from "vis viva" to "work done."

Lagrange, in his *Mecanique Analytique*, states that Descartes "reduced the whole of statics to the principle, that it requires neither more nor less force to raise a weight to a certain height, than would be necessary to raise a greater weight to a height proportionably less, or a less weight to a height proportionably greater. Whence it results that there will be equilibrium between two weights when they are so connected that the perpendicular paths which they can simultaneously describe are reciprocally proportional to the weights. But, in the application of this principle to different machines, we must consider only the spaces described in the first instant of motion, and which are proportional to the virtual velocities."—(Tome i. p. 21.)

Here then we have the simple and natural idea of "work done," changed into the principle of virtual velocities; which, again, has been made the foundation of that of vis viva, from which, again, in the last place, the original notion of "work done" has been elicited in a form adapted to the calculation of the effects of machinery.

With those modifications which the change of conditions would require, I think it probable, that in this equation would be found the best method of calculating the relative efficiency of the paddle and screw, as by it a relation might be got between the quantities of water put in motion *uselessly* in the two cases.

I shall draw this series of papers to a conclusion by a few miscellaneous observations. And, in the first place, I shall revert to a remark previously made with regard to one source of confusion and mystification perhaps more productive of embarrassment to the student than any other, namely, the total want of any clear and distinct notions as to what the symbols used in mathematical treatises on Mechanics really mean. It is a long while generally before he gets any intelligible views of the real nature of the reasoning: long, even, before he sees

Digitized by Google

clearly what is meant by the "measure of a force," and how forces are measured. At the risk, then, of some repetition, I will take a few examples illustrative of what is here alluded to. Suppose the following sentence to be met with: "The attraction of the moon on the earth $\frac{\mu}{r^2}$ at the distance r." Now, this is a short way of expressing what, in plain English, will be a very round about affair. In the first place; the signification of the Greek letter (μ) will be generally explained by the author to be, "the attraction of the unit of mass at the unit of distance;" but we must go still further, and explain more fully. Now, the word "attraction" is, it must be confessed, an ambiguous one to the non-mathematical reader of it (and such the beginner, of course, is), and is often used in different senses, which naturally leads to the beginner's using it with no sense at all.

It is here used with reference, not to the act of attracting, manner, mode, power, or any thing else of attracting, but simply to denote and stand for *a certain number*, namely, the number of feet which the attracted mass passes over in a certain time, namely in one second—which it is usually said to pass over or "describe" "*in consequence of* that attraction:" a good specimen of those combinations of words which convey no earthly information whatever. As to what this motion of the attracted body is "the consequence of," no human being knows, and no mathematician cares. Whether it be the man in the moon himself tugging away at an invisible rope, or whether the moon be a permanent magnet, or an electro-magnet,—in short, make any conceivable supposition you like; but don't imagine that any one of them has the remotest possible connection with the "mathematical" lunar theory. This number, viz., the number of feet over which the attracted body moves during the first second of its moving from a state of *rest*, or (which is more convenient when the body attracted already is in motion) the *velocity* produced in it at the end of one second—that is, *added* to what it had before, (and which velocity itself is again measured by the number of feet over which

Digitized by Google

the body would move in one second,)—this *number*, I say, is the "measure" of the "moon's attraction," or of the moon's "accelerating force," and is itself often called "the accelerating force," whereas, properly speaking, it is "the acceleration." Now, of course this acceleration depends upon the mass of the attracting body and upon the distance between the attracted body and it. Newton's law, or the connection between all these quantities, which he, having first *guessed* or *supposed might be* true, afterwards verified by finding that all the motions of the moon and planets were in numerical accordance with that supposition—this "law" is, that the acceleration mentioned is greater just *in proportion as* the attracting mass is greater, and is less just *in proportion as* the square of the distance between the two bodies is greater. This law is expressed algebraically thus:—suppose that "the attraction of" a mass M produces in a given body, and after having acted upon it for one second, the velocity (A being the number of feet, which in consequence of that velocity, the body would pass over in the next second after, if the attraction were to cease to act), the distance between the two bodies being (R) feet; and suppose that, by the attraction of another mass (m) on the same body, the velocity B is produced in one second, the distance between these two bodies being (r)

$$\text{Then, } A : B :: \frac{M}{R^2} : \frac{m}{r^2}$$

$$\text{or } \frac{A}{B} = \frac{M}{m} \cdot \frac{r^2}{R^2}.$$

It is perfectly optional with us what mass we choose to consider as the standard or "unit" with which to compare others. Let then the mass of the earth be taken as that "unit:" and suppose we take its radius as the unit of distance in the above equation where we may consider M as the mass of the earth, R its radius, and A the velocity produced by the earth's attraction in one second. Putting then M and R each equal to unity, we have for B, the value.

$$B = A. \frac{m}{r^2};$$

Digitized by Google

or, if we prefer, according to the usual notation to denote the "attraction" for "acceleration" produced by the unit of mass at the unit of distance, by the Greek letter (μ), we arrive at the equation B = acceleration produced by the moon whose mass is (m) on the earth, $= m.\frac{\mu}{r^2}$.

Thus then, if we choose, as we have done, our unit of mass and distance, the symbol (μ) signifies 32·2 feet.

Precisely in the same way may the plain meaning of all such equations be got at; and the student should always be able to translate into common English (though most likely very awkward and longwinded sentences) all the equations he uses. In statics, he must get out of the habit of considering the letters P, Q, &c., as representing the dirty pieces of brass and iron which he sees in shops—and learn to look upon them as simple *numbers* (of *pounds*, or *ounces*, or any other unit) which *measure* the *pressures* or *weights*. It is these *numbers* or *ratios* which are *represented* by the straight lines in the parallelogram of forces, &c.: the *number* of units of length (of inches for instance) in a line A P having the same ratio to the number of inches in the line A Q which the number of units of pressure (one pound for instance) in the pressure P has to the number of units of pounds in the pressure Q.

As another instance of a very common misconception, let us take the series.

$$\cos\theta = 1 - \frac{\theta^2}{1.2} + \frac{\theta^4}{1\cdot2\cdot3\cdot4\cdot} - \&c.$$

$$\sin\theta = \theta - \frac{\theta_3}{1.2.3} + \frac{\theta_5}{1.2.3.4.5.} - \&c.$$

Now to many students, who are not altogether without thinking what they are about, and yet have not attained to clear notions on the distinction between *things themselves* and the *numerical measures* of those things—the above series are a sad stumbling block, and well they may be. The reader who has these misty notions, naturally asks—"how can a sine or cosine, which I know to be a number or ratio, be expressed in terms of *an angle*, which I conceive to be an opening?"

Digitized by Google

How indeed! about the *ne plus ultra* of all conceivable absurdities would be the following equation;

sine of a certain opening=that opening$-\frac{1}{2}$ (cube of that opening + &c.

The absurdity arises from considering the symbol (θ) as standing for the Euclidian angle or opening, instead of for a certain numerical fraction or ratio which *measures* that angle and which bears the same proportion to *other fractions* (the measures of other angles), which the Euclidian angles themselves do. Cos. θ is really an abridgment for "cosine of that Euclidian angle the length of whose arc bears the same proportion to the length of the radius, as the number θ does to unity."

Again the *use* of these series is seldom seen, and because the series on the left hand side of the equation is infinite in the number of its terms, the student is apt sometimes to conceive that an immense number of those terms must be taken to get any thing like a tolerably near value for cos θ or sin θ. To obviate this fancy, and at the same time to show clearly the real nature of the equation, let us take a numerical example and work it out. Suppose then, we endeavour to find the numerical value of the cosine of 30 degrees by means of the series. Here (θ) means

$$\frac{\text{length of arc subtending the angle of } 30°}{\text{length of radius.}}$$

and this is the first thing to find.

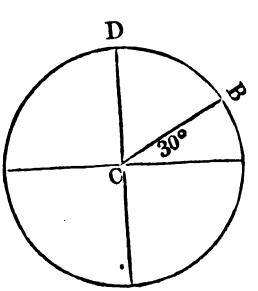
Now, we know that the length of the circumference of a circle bears the proportion to its diameter of (π) to unity: π being nearly equal to 3·1416. We have then,

$$\frac{\text{arc A B}}{\text{arc A D}} = \frac{30°}{90°} = \frac{1}{3}$$

$\therefore$ arc A B $= \frac{1}{3}$ + arc A D $= \frac{1}{3}$ + a quarter of the circumference.

$$= \frac{\text{semi-circumference}}{6}$$

$$\therefore \frac{\text{arc A B}}{\text{radius}} = \frac{1}{6}\cdot\frac{\text{semi-circumference}}{\text{radius}} = \frac{1}{6}\pi = \frac{3{\cdot}1416}{6}$$



so that here (θ) is equal to 5236.

Digitized by Google

Take only the first three terms of the series for cos. θ, so that cos. $30° = 1 - \frac{1}{2}(.5236)^2 + \frac{1}{24}(.5236)^4$.

Keep only four places of decimals in multiplying, and the second side becomes $= 1 - 0{\cdot}137078 + 0{\cdot}003130 = {\cdot}866052$. Now turn to a table of natural sines, &c., and you will find the cosine of 30° to be ·8660254, which agrees with that just found from the series up to the fifth place of decimals, and differs less from it than the cosines of 30°. 1′, or 29°. 59′, differ from the cosine of 30°.

Again reminding him that all the symbols used to denote forces, angles, &c. &c., are nothing but simple, harmless *numbers*, or numerical ratios, and no such bugbears as he fancies —and that the fewer of such misty beings he conjures up the better—I take leave of this part of the subject, hoping it may be of some service.

The student who has arrived in the course of his reading to that part of statics in which the previous principles are applied to the case of *flexible bodies*, such as the Catenary, is very likely to feel some hesitation and doubts as to the propriety of applying to flexible bodies those conditions and equations which have been proved only for *rigid* ones. He must be reminded in the first place, that every flexible body in nature is really composed of an immeasurable number of parts or particles which are perfectly inflexible or rigid; in fact these small elementary particles are the only ones which can be said to be perfectly rigid, for in all ordinary masses, such as beams of wood or iron, &c. the form and arrangement is easily altered by ordinary pressure, so that they are in reality flexible bodies.

Between each pair of these ultimate particles there are forces of attraction (or cohesion, or whatever name you choose to give it) acting, which are to us perfectly unknown in magnitude—and all we can safely suppose concerning them is that the direction of this mutual force is the line joining the two particles, and that the pressure on one is exactly equal but in the opposite direction to the pressure on the other. On these axioms as to the direction and equality of mag-

Digitized by Google

nitude in the mutual forces or pressures, we can find the conditions of equilibrium of any mass of particles whatever—whether that mass be solid, fluid, or gaseous. In this case we consider each particle as being itself in equilibrium under the action of these mutual internal forces together with any given and known external forces (such as that of gravitation), which latter are supposed known in magnitude and direction. By the parallelogram of forces we resolve all these forces, known and unknown, into three sets along three rectangular axis: since the particle is not to move in any direction, it is necessary and sufficient that it should be incapable of moving in any of these three particular directions (for any motion in space must displace the particle along one or other of these three lines): hence, all those forces which tend for instance to displace the particle in one direction along the axis of (x) must be counteracted by those which tend in exactly the opposite direction along this axis. And so for the other two axis of (y) and (z).

Suppose, then, that the known forces, (such as that of gravity) acting on any given particle are reduced to X, Y, Z, acting along the axis. If R denote the mutual force between this particle and any adjacent one, the line joining which makes angles (α), (β), (γ), with the axis; and similarly for the action of any other adjacent particle, we have for the equilibrium of the first particle the equations:

$X + R\cos\alpha + \&c. = o.$ $Y + R\cos\beta \,\&c. = o.$ $Z + R\cos\gamma + \&c. = o.$

the &c., referring to the other actions such as R. Now if we wished to determine the conditions of equilibrium of any one individual particle we must know R, and the angles α, β, γ, &c. But if our object be merely to get a relation amongst the external forces X, Y, Z, &c. for the whole system or mass, we easily effect this by going on to consider the equilibrium of the other particles, for here we shall see the same forces R, &c., entering the equations, but with a different sign. For instance, the equilibrium of that particle, the action between which and the first we denote by R, gives the equations:

$X' - R\cos\alpha + \&c. = o.$ $Y - R\cos\beta + \&c. = o.$ $Z - R\cos\gamma + \&c. = o.$

Digitized by Google

By thus writing down the equations for the equilibrium of each particle throughout the whole system, and then adding together the corresponding sides of these equations, it is seen that we get rid of all such unknown forces as R, and obtain,

$$X+X'+\&c.=o.\quad Y+Y'+\&c.=o.\quad Z+Z'+\&c.=o.$$

in which all the quantities are the known external forces.

It must be carefully observed, that these last equations are not the *conditions sufficient* for the equilibrium of any one particle or of the whole system, (it might happen for instance that the force R was not sufficient to prevent the separation of the two particles between which it acts, when the external forces are of a certain magnitude—in other words fracture might occur in a solid body or dilatation, &c., in a fluid); but they are *some of the necessary consequences when there is equilibrium.*

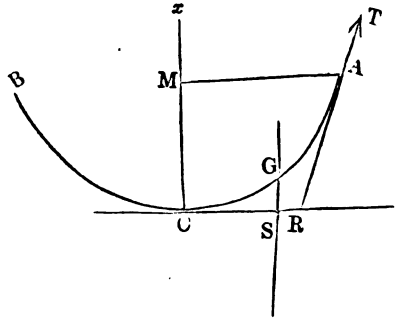
We have taken a system of "particles"—that is, have supposed that the bodies, whose equilibrium we are considering, to be so small that when one point in them is at rest the whole is at rest—in short, that there can be no such thing as rotation round a fixed point in the particle. As we have nothing to do with any such things in nature however, we must, if each of these bodies is supposed to be absolutely at rest, go on to the other equations, viz., those supplied by the consideration of "couples" or "moments." By going through a precisely similar process (and which may be found in the 3d chapter of *Pratt's Mech. Phil.*) it will be seen that although we cannot determine the conditions of equilibrium for any particular body of the system (any further than writing down equations containing unknown quantities,) yet we obtain certain relations amongst the known forces which are *necessary results* of the equilibrium if it exists, though not *sufficient* for that equilibrium.

The relation thus obtained, is the same equation or equations of "couples" or moments, as would be obtained if the whole system of internal actions were left entirely out of consideration. The first relation, obtained above, is, that "the algebraical sum of all the forces resolved along the axis shall

Digitized by Google

each = zero;" the second relation is, that "the algebraical sum of all the moments *round any point whatever* shall also = zero." This last proposition requires a little further explanation. In forming the equation of moments for any one rigid body of the system we are considering, the point about which the moments are estimated is, in the course of the *mechanical* reasoning, necessarily taken *in the rigid body itself*, or rigidly connected with it. But is easily seen that the same *algebraical equation* or relation holds *for any multiple* of the resultant moment, that is, we may suppose the point about which the moments are estimated to be taken outside of the rigid body. In fact, it is obvious that such equations as $Xz - Zx = o$, $Yx - Xy = o$, and $Zy - Yz = o$ remain true if the co-ordinates x, y, z, are changed into mx, my, mz, *i. e.*, if the origin be taken differently, the new axis of co-ordinates however remaining parallel to the original ones. We are at liberty then to refer all the equations of moments for each individual body, to one common origin or point, which need not be connected with any of the bodies.

We shall now, as an example, apply these considerations to the case of the Catenary.



According to the usual notation, let the horizontal tension at the lowest point of the chain be equivalent to the weight of a length (c) of the chain, which is supposed to be of uniform

Digitized by Google

thickness: then if (s) denote the length of the portion of the chain CA, the weight of this portion will be proportional to (s). Let T denote the tension at A in the tangent at that point, A R, which makes an angle (a) with the axis of (x), that axis being also supposed vertical. The portion of chain CA is composed of an immense number of links, each of which is kept at rest by its own weight together with the unknown tensions of the adjacent links. Now by the principles just set forth, we necessarily have the same relations amongst the external forces acting on AC, as would exist were they of themselves keeping the chain at rest, without any reference at all to the internal forces. These external forces are, (1) the weight of each link, (2) the tension at the lowest point, (3) that at the point A. These two latter forces are considered *external* inasmuch as we supposed all the rest of the chain removed, or at least not included in our inquiry as to the equilibrium of the portion CA. All that we have now to do is to resolve all these forces, and take their moments just as if the body were not a flexible one.

Resolving vertically, then we have the equation. Sum of all the separate weights of each link—T cos $a=o$; or weight of (s) —T cos $a=o$.

Resolving horizontally, tension at C—T sin $a=o$; whence we easily have,

$$\frac{c}{s}=\frac{\text{tension at the lowest point } c}{\text{weight of length of chain } (s).}=\frac{\sin a}{\cos a}=\tan a=\frac{dy}{dx},$$

which is the equation to the curve. The tension at A is equal to

$$\frac{\text{weight of } (s)}{\cos a} \text{ or weight of } (s).\times\frac{ds}{dx}.$$

So far then as merely finding the equation to the curve, we have no occasion for the equation of moments. This however will serve us to find the centre of gravity of the portion of the chain AC; for let $\bar{x}$ and $\bar{y}$ be the co-ordinates of G the centre of gravity. Then, taking the moments round the lowest point C, for instance. Sum of the moments of all the weight of the links=moment of tension T.

Digitized by Google

$$\therefore \text{ weight of } (s) \times \text{C S} = \text{T } (y \cos a - x \sin a)$$
$$= \text{weight of } (s).\ (y - x \tan a).$$
$$\therefore \text{ C S} = y - x \tan a = y - x.\frac{c}{s};$$

where (x) and (y) are the co-ordinates of A. Knowing $\bar{y}$ therefore we can determine $\bar{x}$ from the equation to the curve. The same might have been obtained, of course, by taking the moments round A instead of round C, and this would have also been shorter as not involving the elimination of T. The co-ordinates for the centre of gravity thus found agree with those found by different methods, which may serve to convince those who have any doubts as to the use of these "equations of moments" when the bodies themselves are flexible. A little attention however to the preceding remarks, will show clearly the grounds on which such usage is established. In the same way might be found the centre of gravity of any curve kept at rest by a system of equal parallel forces applied to each point of the curve, together with other external forces.

It will be observed also, that we have availed ourselves of the very same circumstance to get rid of unknown forces in considering the equilibrium of bodies, which we did in a former case to get rid of them in considering the motion of bodies. These inimical forces, which would otherwise prevent our attacking such problems with success, by thus waging war and mutually destroying each other, give the same vantage ground to the mathematician which similar events do in living warfare, "internal feuds" and antagonisms allowing that to be easily seized and subdued which otherwise would be impregnable. John Bernoulli would be very apt to assert, that these internal tuggings of particle against particle, were something "real and substantial." The preceding methods are applicable to the equilibrium of all flexible bodies, and not only to them, but to fluids and gases. In the latter, it is however expedient, rather we should say necessary for the investigation of physical effects, that the unknown internal forces should be kept in the equations for the purpose of determining them, which we are often enabled to do by the aid of cer-

Digitized by Google

tain laws discovered by experiment; as for instance Boyle's law of the proportionality of the pressure to the density. It is also found convenient to consider the pressure at any point in a fluid mass as a function of the co-ordinates of that point, and as varying by imperceptible degrees from one point to another. By a very simple process the equations for the equilibrium of any portion of the fluid are formed, in which the differentials of the pressure at that point are made to take the place of such forces as R in the former part of this paper—and then, by the aid of the integral calculus the whole circumstances of the equilibrium are investigated. It should not be forgotten however that in such equations as

$$\frac{dp}{dx}=\rho\,X,\frac{dp}{dy}=\rho\,Y,\frac{dp}{dz}=\rho\,Z.$$

the pressure (p) is simply that which we have hitherto called the mutual action or force between two adjacent particles, and that we might, just as in the former cases, eliminate all these pressures, so as to get a relation amongst the *known* forces X, Y, Z, &c.: and that the only reason this is not done, is that this *unknown* pressure is precisely the very quantity we *wish* to determine by means of its relations with *known* quantities. The reader may ask why this is not done in the case of solid bodies as well as in fluids? to which we can only answer, that we are not nearly so well acquainted with what takes place in the interior of solids as we are with the laws of transmission of pressure in fluids, and that from the very nature of the case we are unable to experiment directly on the subject so well as in the other cases. It is highly probable, however, that the time will come when it will be as easy to assign the exact pressure in the interior of a solid body whose nature is known, as it is now to do the same for any point in the interior of a fluid such as water. The whole question of the strength of materials, as well as the still more important and intricate questions of the transmission of heat and light through solid matters, renders it indispensable that this problem should be solved before we can learn any thing certain as to the mode in which such kinds of motion are propagated.

Digitized by Google

History of the Introduction of Horse, or Flying Artillery, into the Armies of Europe, Communicated.—By Captain C. Colville Young, Royal Artillery.

The principle of this new Artillery is, that it is organised in such a manner as to perform movements the most rapid and the most unexpected; thus it can proceed with celerity either to a point threatened by the enemy, or a post which by a decisive attack it is intended to carry, follow the horse every where, if needful, and crush the enemy by the combined effect of all the means of attack and defence which the theory of the military art, judgment, and experience, can suggest.

In the campaigns of 1757, 1758, and 1759, against the Russians, it often happened that the Prussian light horse, at the very moment when they imagined themselves to be sure of success, met with a battery of cannon, though no infantry were present, which led them to suppose that the Russians had horse artillery, able to follow all the movements of the horse. The fact being ascertained, Frederick the Great introduced this artillery in his army in the spring of 1759, when the writer of this sketch, at the head quarters of Reichennersdorff, near Landshuth, saw him nearly every morning exercise this new corps himself, and direct its manœuvres. The king made also a successful trial with his horse artillery before he left that camp, by covering with it a reconnoitering party beyond Lieban, on the retreat of his dragoons, in a manner so effectual that all the attacks of the enemy's horse, though far superior in numbers, completely failed. The Austrians were the first who imitated this new military establishment: in 1783 they manœuvred with horse artillery near Prague, and since that time it has been introduced into the British, Swedish, Saxon, and Hanoverian armies, yet with considerable difference as to the calibre of the ordnance, and the way of mounting the artillerymen. The Prussian horse artillery consists of 6 pounders, the Austrians of light 3 pounders, the Hanoverian of heavy 3 pounders, the Danish of

Digitized by Google

one pounder, &c. The Prussian artillerymen are on horseback; the Austrian ride on the carriages of the gun; the Hanoverian ride partly on horseback, partly on the gun-carriages and wursts, &c. &c.

But no European power has hitherto derived such important advantages from this new artillery as France, where it was introduced in the year 1792, and soon carried to great perfection. In order to give it the advantage of a superior fire, the French flying or horse artillery consists of 8 pounders, and 6 inch howitzers; the ammunition is carried in light caissons, and most of the artillerymen are mounted while others ride on the wursts. By this arrangement, in addition to the known abilities of the French Cannoniers, the republican horse artillery soon acquired a decided superiority over that of the Austrians, and maintained it during the whole war.

Since the formation of the horse artillery, it has been found possible, without clogging or retarding the movements of advanced guards of cavalry, to make a more numerous artillery march and manœuvre with them, as well as reserves of pieces of a calibre sufficient for every enterprize with which the corps of advanced guards might be charged.

This observation recals to mind the advantage and importance of the horse artillery, and induces us to present to our readers a few interesting particulars concerning the institution, and the improvement of this sort of artillery.

It is well known that the Prussians were the first who employed it: the Great Frederick had invented it at the time when, in order to resist the league formed against him, his genius multiplied his resources; where the same army, conveyed with a celerity and precision till then unknown, triumphed over superior forces, and during the same campaign, upon opposite frontiers, to the east and west of his dominions. No doubt he first tried to accelerate, and likewise to simplify, the marches of columns of artillery when on a route, then made use of the same method for the marches when manœuvring in the presence of an enemy, and at length ap-

Digitized by Google

plied it to the movements and engagements of advanced guards.

The horse artillery was introduced into the Austrian armies during the reign of Joseph II., but it was by no means made a principal object. It remained in a state of imperfection that did not admit of the acquisition of all its advantages. The artillerymen were conveyed upon caissons, or covered waggons, which were made in the form of an old hunting carriage, called *wurst-wagen*. These caissons differ from the common ones only by having the cover stuffed, which affords the facility of placing the gunners upon it in the attitude of a man on horseback.

In France it was for a long time proposed in vain to form a flying artillery. In 1791, M. Duportail, minister of war, authorized the Commanding officer of the division of Metz to form two companies of horse artillery. The success of this experiment, the extraordinary skill in the choice of officers and men, who were employed, and who were in a few weeks able to manœuvre with the light troops, dispelled every doubt upon the subject, and showed how fit the French were for this service.

In the year 1792, a short time before the declaration of war, M. de Narboune, who had succeeded M. Duportail, and formed, at his office, a committee, composed of very intelligent officers, summoned thither the generals of the three grand divisions of the armies, and the principal field officers of the artillery and engineers, in order that they might inquire into and decide upon the means of perfectioning and extending in the French army the use of the horse artillery.

A more correct idea of the organization of this new artillery cannot be given, than by here relating the result of this conference.

It was unanimously resolved, as leading points,

1. That a numerous horse artillery, well served, and always kept complete in men and horses, is the surest method of protecting the evolutions of a corps tolerably trained, by supporting its attack by the bayonet, and rendering almost

Digitized by Google

nugatory, by positions taken opportunely and with celerity, the advantage that troops better disciplined might promise themselves from their superiority in manœuvring.

2. That for the employment of horse artillery, and the regulation of the service, training, &c. it is to differ from the field artillery only in the cannon being provided with better horses, and transported with the greatest swiftness, wherever it can be used with more effect; so that the artillerymen, being always able to follow their pieces, can begin to fire as soon as they are placed.

3. That to accomplish this object, it is better that the artillerymen should be all on horseback, than if they even partly rode upon *wursts* or stuffed caissons, because accidents are less frequent, movements more easy, retreats more certain, and horses more readily replaced.

4. That, without excluding pieces of any calibre, it appears most advantageous to make use of 8 and 12 pounders and howitzers.

5. That it is useless to train the horse artilleryman like a dragoon intended for cavalry manœuvres; that this would be diverting him to no purpose from the principal object; that it is difficult, if he be well seated on horseback, accustomed to mount and dismount nimbly, to guide his horse freely, without confining him to any particular rank in following the pieces, and leaving to his judgment the task of learning to know and to execute, if required, the cavalry manœuvres, in which he may happen to be engaged.

6. That harness with long traces should be employed, whenever the impossibility of making use of it does not force the artillerymen to renounce it, because the horse remaining harnessed while the pieces are firing, all the time that is necessary for taking off, or putting to the limbers, is gained for profiting by the position taken, and because ditches and rivers can, in this manner be crossed with the greatest celerity.

7. That in order at once to form a sufficient number of companies of horse artillery, without weakening the regiments

Digitized by Google

of artillery, it will be sufficient at first to attach to each piece two intelligent artillerymen, and to take the remainder from other corps, and chiefly from the light troops.

Upon these principles this establishment was organized in the French armies, which have reaped so considerable an advantage from it in all their campaigns.

General Dumourier demonstrated all the importance of this artillery in an invasive war, at the end of the campaign of 1792, in Belgium; and there have since occurred other very remarkable instances of success owing to the horse artillery, both in offensive and defensive operations. At the affair of Waterloo, while General Pichegru commanded the army of Flanders, 4,000 men manœuvring with horse artillery (and this testimony is adduced by officers of the combined army) sustained the attack of an army of 30,000 men, supported by a train of artillery at least treble that of the French.

Bonaparte, at the battle of Castiglione, after the raising of the siege of Mantua, having ordered General Dumartin to collect and place to advantage several divisions of flying artillery, broke the lines of the Austrians, and decided the fate of Italy.

The horse artillery did not a little contribute to the gaining of the battle of Ettlingen, in which General Moreau, although inferior in cavalry, supported his left wing against all the cavalry of the Archduke. A similar manœuvre procured General Hoche similar success upon the Rhine in the last affair of Newvied; General de Belle, who commanded all the artillery, rapidly carried in front, and firing openly to silence the fire of an entrenched line flanked by strong redoubts, is one of the officers who formed the first companies at Mentz.

The Archduke, availing himself of these experiments, had greatly augmented and perfected this artillery in the Austrian army. He attached some divisions of horse artillery to different corps of light troops, and he thence derived the greatest advantages in the rencounters and engagements of advanced posts, which preceded the decisive battle of Stockach.

Digitized by Google

This artillery is now become indispensible in all armies; it can follow the cavalry almost every where; it crosses rivers and morasses, the passage of which is impracticable by foot artillery; it rapidly proceeds in a body upon an unforeseen point of attack, turns an enemy's corps, cannonades it in flank or in rear, can do the duty of advanced posts, that of stationary artillery, that of the rear guard, and lastly, that of the corps de reserve, from which it may be detached, according to circumstances. It has not the inconvenience which has been generally imputed to foot artillery, of retarding and clogging the manœuvres of the troops; accordingly the French have already restricted the use of the latter almost to the sole service of sieges, with the exception of 4 pounders, which remain attached to battalions.

During the time Field Marshal the Duke of Richmond was Master General of the British Ordnance, a corps of horse artillery was formed, and it is, in point of discipline and appointments, superior to that of any other nation.

Description of Flying or Horse Artillery.

The establishment of *flying* or *horse artillery* came to us originally from foreigners; it formed a part of the military force of the Prussians, and its introduction into France took place during the Ministry of Narbonne.

The principal object of this artillery is, to possess such a peculiar organization, that it may execute with facility not only the most rapid, but at the same time the most unexpected movements; that it may be enabled quickly to bear either upon a point that is attacked, or on a post which it is required to carry by a decisive attempt; to be constantly attendant upon the cavalry; to confound and embarrass the enemy by every mode of attack and defence, which the theory and practice of the military art and of artillery can possibly suggest; and, lastly, to effect these various operations, by the knowledge of positions, &c. &c.

Digitized by Google

From its celerity, this artillery is enabled to connect itself with troops of cavalry; to cover with its fire their manœuvres, and to assist in rendering them superior to those of the enemy; it can either remain united in a body, or separate itself into detachments, according to the influence of local circumstances, and the appearance and position of the manœuvres, and troops of the adversary; the former of which should, however, be cautiously foreseen, by an able and expert officer.

A commander well grounded in his art will always so dispose of his men, as to direct their fire, in an oblique direction, advantageously on the lines and main body of the enemy; he will also vary his motions, according to the different movements of his adversary, so as to produce disorder and confusion among them, which may be effected by a variety of customary manœuvres used in the art of war; but, above all, he will not neglect the most important and decisive point, that of *covering* and *crossing with fire* the ground occupied by the enemy, as well as that by which he is anxious to advance.

It will readily be imagined, that the execution of all this requires a certain degree of talent and information, which must, at least, be the result of a well-digested theory. It is therefore of importance to the public advantage and utility, that this part of an army should be guided and directed by able and well instructed commanders, officers, and cannoniers; for what can with any certainty be expected from men, even in defiance of the utmost zeal and bravery, if they have not previously studied their art? The organization of this corps should therefore be similar to that of the artillery; and it appears indispensible that individuals should be drawn from all classes, and that, united together as a part of one whole, their instruction, and the examination which is exacted by the ancient artillery, may be common to both. Lastly, it would be possible, in organizing the flying artillery, to render it a more unique body; for the cannonier, necessarily diverted from his particular avocation, by the attention which he is compelled to bestow on his horse, &c. is generally considered as be-

Digitized by Google

ing at once an indifferent horseman, and but little versed in the various manœuvres which belong to his art.

In order to give the flying artillery the advantage of a superior fire, they use cannon of eight inches, and howitzers of six. These two calibres appear to have hitherto completely answered every object proposed. Hence, the ammunition required for this dimension did not occasion an excess of conveyances, or an embarrassing weight, which, in bad soils, would follow very tardily the rapid movements which this artillery is constantly compelled to make. An eight inch piece, pointed to six degrees, carries a ball more than 600 toises, and 480 with an elevation of twenty lines. This projectile is more than sufficient to overthrow entire lines; to create confusion, and open the ranks of the soldiery; and its effects may be considerably prolonged by other means. If they use large ball-cartridges, it is certain, that, at a distance of 300 or 350 toises, a fourth of them at least, would be effectual; and those with small balls, if thrown at a distance of between 2 and 300 toises, more than one-third would reach the enemy.

An howitzer of six inches will, well directed, accomplish more than one object; when pointed to six degrees, it expels the charge about 600 toises; in its fall it crushes every thing which it meets with, and after having broken the lines and spread dismay among the troops who were exposed to its irregular and vibratory progress, it bursts, and occasions the greatest confusion, particularly among the cavalry; and, lastly, an howitzer, when more approximate to the adversary, will send a cartridge, containing sixty-one balls, of seventeen lines each in diameter, the effects of which are prompt, and uncommonly destructive.

The course of the bomb depends, in some instances, on the howitzer, by giving it such an inclination as will tend to augment the degrees; that is, the angle of projection, which is presumed to be applicable to the object proposed. An artificial or natural declivity of the earth is one of the means which may be employed, if peculiar circumstances should

Digitized by Google

require a large elevation in the amplitude of the projectile.

The advocates for large calibres wish also to have howitzers of eight inches ; but notwithstanding that their effect in the field, &c. differs very little from those of six inches, their weight is nearly double, their diameter is much larger, and, in using them for battle, they would require an abundance of supernumerary carriages and horses, and increase the expenses of ammunition in every point of view without producing any real advantage.

Besides these observations, it may also be remarked, that the increase of weight, which is attendant upon a howitzer of eight inches, produces a very considerable difference in the celerity of the manœuvres; but, it may be replied, that an advantage may yet be gained in this respect, by piercing a six inch howitzer for eight inches. This method, however, employed in the seven years' war for cannon, and which succeeded so badly, only tends to increase the embarrassment and trouble attendant upon transporting ammunition, which is prodigiously augmented by this procedure.

The field carriages employed in the flying artillery are the same as those used in the foot; the only change, which has been introduced in certain companies, is in the formation of the butt-end of the sides or *cheeks*, which are elongated, and more elevated, in order to obviate better, in the recoiling of the machine, those obstacles which often present themselves, and likewise to prevent the end from sinking into the earth when it is soft. We have already had occasion to speak of the superiority of our carriages, the simplicity and solidity of which render them far preferable to any complicated ones whatsoever. In fact, on every occasion, the weight of the cannon or howitzer being equally applied on each of the four wheels, so effectually facilitates its progress, that it overcomes every thing, and the use which has been made of it in the present war (1794), as well as in North America, fully evinces the truth of the above remark; though false reasonings have, in spite of experience itself, been urged against it, by

Digitized by Google

such as would maintain the private interests of individuals, so manifestly injurious to the public wealth.*

When it is intended to engage the enemy, even by way of surprise, the preparations for action are the same as those for artillery in general.

The fore-wheels are taken off; the cords are applied, and, during the whole action, whether it is intended to advance, to retreat, to ascend an eminence, to cross even a ravine, or lastly, to contend with all the inequalities of the soil, the manœuvres are constantly performed by means of these cords: and, in case of necessity, a few applications of the hand, by the cannonier, will increase the means of rapidly surmounting any obstacles which may occur in the route. Hence it appears, so far from the fore-wheels being a superfluous and *embarrassing part* of the carriage, they are essential in this very case. They enable the piece to vary its fire, either circularly, horizontally inclined, when advancing, retreating, or in suddenly changing its position; and the cannonier is relieved from all fatiguing service relative to the ordnance. This method of manœuvring possesses all the advantage of keeping the horses at a sufficient distance, to secure the men, who are serving the cannon or howitzer, from those accidents which may be occasioned from their being frightened or restive, when too near the explosion, and general disorder which they are otherwise exposed to.

* All two wheeled carriages, laden with a heavy weight, incontestably sink more into the earth than four wheeled ones, because the whole pressure lies on the felloe, which bears upon the earth, according to the radius of the wheels, proceeding from the centre of the axle-tree, to the point of contact of the circumference on the ground; and in a soil newly dug, softened by rains, &c. they produce ruts, which become so excessively deep, that the progress of columns is often intercepted. The German war, of 1756, fully demonstrated the thorough inconvenience of two wheeled carriages in bad roads, for how were the artillery then embarrassed and obstructed? Doubtless their progress might be continued comparatively speaking if they take the precaution of driving them only on dry and level ground, or on the pavement; and, likewise if anything is previously arranged for their advantage. Practice has therefore demonstrated the utility of fore-wheels, and, as they have been adopted from a conviction of their excellence, by the most able generals, and experienced military men, insidious remarks against them, and the motives which have urged their use, however severe, must remain without effect.

Digitized by Google

The ammunition, for the use of the flying artillery, follows the pieces in the usual machine, and in waggons called *wursts*.* This last conveyance is suspended, and, from the

* The waggons called *wursts*, being suspended, are peculiarly advantageous, as they do not shake the ammunition contained in them, and hence preserve it from being deteriorated. These waggons are attached to the flying-artillery, which, by this means, can be promptly conveyed to any part where it may be required; and this is the principal use of the light artillery, which is intended for the vanguard, or to follow the cavalry, and perform the most rapid movements. From a consideration of the principles on which this artillery is founded, it is evident of what importance it is, that those to whom the direction of it is intrusted, should be well acquainted with military tactics, and have a thorough knowledge of artillery; not the common place knowledge of a few particular motions, but a general and extensive information in the art of war, in order to reap the greatest possible advantage, by a nice and skilful placing of it, so as to annoy the enemy in every direction, and protect the movement of the troops, which are either attacked or attacking, and by the different positions which circumstances may require to be assumed, avoid becoming a sacrifice to the enemy's fire; or at least, to afford them few means of succeeding, but, on the contrary, to throw in their way endless obstacles to overcome. Finally, as these waggons contain less ammunition than the others, greater economy should be observed, and consequently it should be employed only on the most efficient occasions.

Hence, to attain completely the desired utility of the artillery in question, it is indispensable that the persons commanding it should possess true military knowledge, and be likewise officers of artillery; it is also requisite that the Subaltern officers and cannoniers should be acquainted with manœuvring; they should likewise know, that the science does not merely consist in firing rapidly a numerous succession of balls, but, on the contrary, to fire only with success at proper distances, and from their own knowledge judge of those distances, so as not to consume all their ammunition in absolute uselessness, and by such faulty conduct find themselves destitute at the moment when the action is in its hottest part, and most perilous. The cannoniers should also be well instructed, know the use of their ordnance, know to manœuvre it well, and be thoroughly instructed, from practice, in its true and best uses.

But this end can never be completely attained by the formation of separate companies; not but that every praise should be given to the distinguished services of this artillery, during the last campaign, in which it proved, on every occasion, its superiority over that of the enemy; and how much Frenchmen, animated by patriotism, redouble their exertions, their bravery, and their talents, when the point at issue is self-defence, yet, in order to derive every possible advantage in future, it has been thought requisite to form regiments of horse artillery, which, during peace, will be united in the same schools as the foot. By this means, they can follow the same routine of instructions, as these cannoniers to whom they are in a manner relative; their organization not permitting their instruction to exceed this, on account of the attention which must indispensably be bestowed on the horses, &c. Still, however, it is to be wished, that the commanders were artillery officers, in whom theoretical principles should be the foundation of practice, and that this

Digitized by Google

flexibility of its motions possesses the double advantage of perfectly preserving the cartridges, &c. and, at the same time, carrying the men whose business it is to serve the ordnance.

At the period of the institution of horse artillery in 1792, which is likewise denominated *flying artillery*, *wursts* alone were permitted to be employed, each of them were made so as to hold eight, or, at least six men. The construction of these carriages has been established in consequence, and the experiments made to ascertain the possibility, and subsequently the practice in war have proved, that the waggons completely answer the proposed end, and that the cannoniers, placed on the top, are seated both safely and commodiously. We have had a number of them constructed at the Arsenal of Donai, which are always proved previous to being admitted into the equipment of a company; but the hurry and precipitation with which they were obliged to provide for the arming of these companies, would not allow more than two for each of them; and we sent two years ago, a memoir, to the then minister at war, to request that none other but *wursts* might be given to the flying artillery, who, by this means, might do without being mounted, at least *in toto*. In fact every eight inch piece of ordnance ought to have two waggons or two *wursts*, which might transport a greater number of men than are necessary for working a piece of that size.* For the how-

artillery, in order to afford every advantage, should be guided, in war, by experienced men.

We are well convinced of the inutility of those artillery corps which were organized in the legions of the new levy, &c. &c. who persuaded themselves, and wished to persuade others, that they were really Engineers, because they assumed that name, and could make a noise. In fact, this great abundance of artillery, vested without distinction in every hand, and directed by ignorance, too often produces only an excessive consumption of ammunition, and there confines its dreadful havoc. It was therefore to remedy such a serious inconvenience, that regiments of horse artillery have been formed, from which a real benefit and advantage must result in the moment of action.

* The thirteen men who are employed in serving it are by no means too many, if it be considered that, during the action, the enemy's fire may kill or disable some of them, and that others are necessary to watch the drivers, &c. whilst they are engaged, thus to prevent the flight of any of the carriages or horses. Thus it is another disadvantage which those persons labour under, who ground the bene-

Digitized by Google

itzers, three wursts would be necessary, which would furnish more; and hence, for four pieces of ordnance, the whole of the conveyances requisite for their ammunition would, at the same time, contain twenty-four men; and as these wursts carry less ammunition than the usual waggons, there might likewise be added one of each kind, which would allow more room for the conveyance of the cannoniers, and of course, lighten considerably the weight of each wurst.

Every single wurst, the top and ammunition included, does not quite weigh nine hundred pounds; if a thousand or twelve hundred pounds be added for the weight of six men, the total amount will then be about two thousand pounds; and, as the load on common waggons is always estimated at two thousand, or two thousand four hundred pounds, drawn by four horses, it is impossible not to acknowledge the superior advantage of these wursts, which, harnessed with six, and sometimes eight horses, are susceptible of all the various rapid movements required of them: but a few words more respecting them,—the cannoniers are pleasantly and safely seated on these carriages, and need not apprehend any danger; their feet are firmly supported, and, on every occasion, they can descend, without any difficulty, either singly or together, and yet not incommode or confuse each other.

From what has been already stated, it may be concluded, that the cannoniers of the flying artillery need not be mounted; and, in that case they might be taken indiscriminately, or alternately, from the artillery regiments. Indeed, it is the only certain means of rendering this service in every respect truly useful, because it may then be commanded by real artillery Officers, and by expert and instructed cannoniers.

It is unnecessary to enter into economical calculations rela-

volence of their invention on a faulty and injurious paucity of men, particularly with regard to the flying artillery, which, according to their calculations, would often be without cannoniers to replace such as accident might remove, and likewise the possibility of getting any; hence, the firing would cease, inasmuch as the rapid movements, which form the very essence of this artillery, will not permit men on foot to follow them.

Digitized by Google

tive to this flying artillery, organized as proposed, and as it was originally intended: they are too evident in the advantages which will accrue from the horses and harness, and this object is no trifling consideration.

The objections which have been advanced, with regard to the accidents which may happen to the wursts, and by their privation dismount a certain number of cannoniers, are equally applicable to horses, many of which may be disabled or destroyed by the enemy. Thus whatever modifications may be brought forward under this head, it would always be possible to advance others equally valid. But that which principally militates against the ideas here hazarded, is the experience of the last campaign, which has demonstrated the advantage of mounted cannoniers, whence they are enabled to keep pace with the cannon, and need only remount their horses when any new position is about to be adopted; instead of which, the waggons filing off with rapidity, as soon as the change is decided upon, it is difficult for the cannonier to keep up with them, or, on the other hand, if they are compelled to wait until all the men are mounted on them, the delay which would thus be occasioned might prove injurious to the manœuvre itself, and entirely defeat its object, independent of the difficulties which the ground to be traversed may present, and the accidents of overturning, which may happen.

The advantage of our horse-artillery would be doubtless still more conspicuous, if the troops of cavalry, &c. with whom they perform their manœuvres, knew how to cover the batteries, and to display them only at the proper time; for, if the enemy be aware of the approach of a division of flying artillery, they immediately prepare, at a distance, to avoid their fire.

Though the bore of eight inches be the more preferable calibre for the general service of the flying artillery, still they may employ very advantageously the cannon of twelve, for it is equally susceptible of celerity in its motions; the weight of this size is only eighteen hundred pounds, whence six, or

Digitized by Google

at most eight horses, should the ground be difficult, would be more than sufficient to execute, in conjunction with the cavalry, or chasseurs, the most prompt and decisive manœuvres. This calibre is particularly useful when it is intended to attack an entrenched camp, to destroy palisades, abattis, or the walls of small enclosed towns; and, lastly, when it is requisite to reach and annoy troops at a distance, to disturb the progress of columns, which are advancing towards a certain part of the line, in order to reinforce it, and the junction of which, it is of importance either to intercept or retard.

The ammunition of these pieces would likewise be conveyed in wursts; those intended for the howitzers might be appropriated, as it would only be necessary to alter the interior divisions, and in the construction of these, the same as in all other waggons, they are so arranged, as to be capable of receiving, if necessary, an entirely new conformation. There should likewise be, in each division of artillery, placed along the line a reserve of ordnance of this calibre, in order to be employed ultimately in this service, and consequently ready accoutred, harnessed, &c.

With regard to the cannoniers, they will be drawn from the regiments attached to the divisions; and as these wursts are covered with leather, stuffed with horse hair, and suspended, there is no necessity that the cannonier should be previously initiated, in order to keep himself on this elastic seat, the motion of which is as soft as any other carriage similarly hung.

The preceding observations naturally introduce the following, we therefore venture to propose, that only one piece of ordnance of four inches should be given to the battalions; the ill-extended custom, or rather perhaps the abuse of that prodigious number of small cannon, has proved how much they are injurious, in general to the end proposed. And in fact, it is but too well known, that the ammunition of these is often consumed without the least advantage whatsoever resulting, all their effect being confined merely to making a noise, that the baggage, &c. is uselessly destroyed; and that the retention of so many men, horses, and waggons, and of so much harness,

Digitized by Google

cannon, ammunition, and baggage, would constitute a very considerable saving, and enable the government to augment the standing artillery, the only one from which anything can reasonably be expected; both from the power and energy of their pieces, and from their commanders, who have properly studied how to employ them with the greatest advantage.

Extract from Artillery Depot Memorandum Book.

30th June, 1848.

Yesterday in mounting the 56 Pdr. iron gun of 98 cwt. on its carriage and platform, the hook of the lower block of the gynfall broke as shown in Plate 71 when the gun had been raised about 3½ feet from the ground.

Another block was procured, the gun raised sufficiently high, and when about to be lowered into the trunnion holes, the hook of the lower block again broke in nearly the same place, and the gun fell into its position without accident. In repairing the hook, orders were given to make it ¼ inch thicker, or 2⅜ in diameter.

Teak.

Teak will be found to differ in weight from 39 lbs. 6 oz. to 52 lbs. 15 oz. the cubic foot when seasoned, the heaviest known when green is 57 lbs. 9 oz. to the cubic foot, some of the Teaks in the Cochin forests weigh as much as sixty pounds the cubic foot when green.

Statement showing the difference in the cost of Percussion Caps manufactured in England, and the Presidencies of Bengal, Bombay, and Madras as calculated in 1847.

		RS.	A.	P.		
Manufactured in	England,.....	2	3	2	per	1,000
,,	,, Bengal,.....	3	2	0	,,	,,
,,	,, Bombay,.....	2	3	6	,,	,,
,,	,, Madras,.....	2	2	5	,,	,,

Correct.

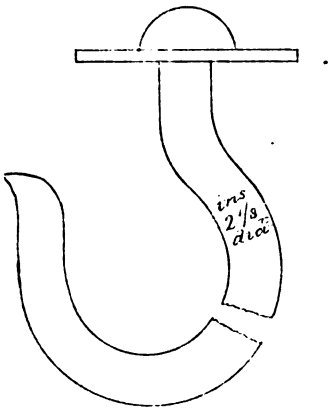
A. F. Oakes, Captain,
Director.

Digitized by Google

Miscellaneous.

Plate 71.

Sketch of the Hook of the lower block of the Gyn-fall, which broke in mounting a 56 Pdr. Gun of 98 Cwt.



Madras Art'y Depôt

Printed by T. D.

Digitized by Google

Digitized by Google

INTRODUCTION.

HAVING published a description of my Diakoptist* or War Engine for breaking Infantry Squares, I shall leave it to those who are more capable of judging than I am, *whether or not, it can be advantageously used in European warfare, as an Aid to Cavalry in breaking Infantry Squares;* it is certain that it can be of no use in India, where our opponents are not likely to be sufficiently advanced in Modern Tactics to know even what an Infantry Square means, much less, how to form one in the presence of an enemy.

In the construction of this Diakoptist, I have had in view, simply to bring forward a Machine possessing the power of throwing a mass of armed men, otherwise impenetrable, into such disorder, as to place them in the most favorable position imaginable for the attack of Cavalry, at the same time effectually screening the men and horses, employed in its propulsion, from the direct fire of the enemy to be attacked.

It must be borne in mind that the machine has been made out of old materials, which I happened to have on hand; for it will be obvious to any one, that the mechanism of the guiding apparatus is open to improvement, which, can hereafter be arranged by any skilful mechanician, in the event of the invention being favorably received by the Military Authorities in England; and I am encouraged to hope it will be so, from the favourable notice which it has met with, in this country, from the distinguished General Officers hereafter named.

* That part of the Mantelet which is below the Axletree should be so constructed as to yield to an obstacle and retain its place after passing such obstacle.

Digitized by Google

Major General Sir E. K. Williams, K. C. B. and K. C. T. and S., Commanding Centre Division of the Madras Army, did me the honor of inspecting the Diakoptist in February last, immediately after I had completed it; and from the encouraging manner in which the Major General spoke to me, of the probability of its meeting with the approval of the Military Authorities in England, I was induced, at his kind suggestion, to submit it for the inspection of His Excellency Lieutenant General Sir George H. F. Berkeley, K. C. B., Commander-in-Chief of the Madras Army, who also did me the honor of approving of it; subsequently His Excellency Major General the Right Honorable Sir Henry Pottinger, G. C. B., Governor of Madras, on my informing him that I had constructed this Machine, was pleased to express a wish to see it; the results of the several inspections were as follows:

Major General Sir E. K. Williams, K. C. B. and K. C. T. and S., inspected the Diakoptist on three different occasions, in February, and in March last, before he did me the honor to recommend it to the favorable notice of Lieutenant General Sir George Berkeley. After having it wheeled by word of command to the right and left, at a walk, and at a trot, as also having it circled to the right and left, he directed me to fix a flag staff at 300 yards distance, and another on each side of it, just sufficiently apart to admit of the Machine passing through them, without touching; he then desired me to advance the Machine at the *Charging* pace, and to knock over the centre staff, leaving the outer ones standing. The feat was accomplished to the entire satisfaction of the Major General; the centre flag having been knocked over by the spear of the Machine, and the outer ones left standing. The Major General afterwards sent me the following note, which I have his permission to publish.

My dear Captain Oakes,

I have much pleasure in attending to your request, and readily give my opinion as Commanding the Division in which you are placed. From the first inspection of the Machine planned by you for break-

Digitized by Google

ing through a square of Infantry, I was struck by its feasibility as well as the quickness of its movements and rapid turnings; and I do think much credit is due to you for the invention, and its apparent practicability.

Believe me,

Your's very faithfully,

March, 1848. (Signed) E. K. WILLIAMS.

On the 27th March, 1848, and at the request of Major General Sir E. K. Williams, His Excellency Lieutenant General Sir George Berkeley, K. C. B., Commander-in-Chief of the Madras Army, did me the honor, shortly after his arrival at Madras, of inspecting the Machine, and seeing it move at speed, on which occasion, His Excellency expressed himself much pleased with its performance; adding, that provided the advance to the *Charge* were made on tolerably level ground, it could not fail to render a very essential service to the Cavalry.

On the 1st of September, 1848, His Excellency Major General the Right Honorable Sir Henry Pottinger, G. C. B., Governor of Madras, inspected the Machine, when it went through the same trials as before, and with the same success; on which occasion, His Excellency was pleased to express himself in a manner fully corroborative of the opinion given on it by Lieutenant General Sir George H. F. Berkeley, &c. &c., and of Major General Sir E. K. Williams, &c. &c.

If objections be made to the perilousness of the posts of the driver and guide—I answer—they are not so much exposed in charging an Infantry Square, as a Cavalry soldier is; and after the square is once broken, no one will deny, that the Infantry men composing the fragments of it, would have quite sufficient work on hand to oppose the Cavalry, by which the Diakoptist would be instantaneously followed, to have it in their power to interfere, at such a moment, with the onward progress of the Machine. Again, it may be said;—what a cumbrous and useless carriage it would be to accompany an army on a march—I deny this—for with the commonest ingenuity, it

Digitized by Google

might be temporarily converted into a very useful cart to carry stores or forage, &c. &c. (without, in any way, being injured by the metamorphosis,)—thus; let the rear of the Machine become the front of the cart, attach a pole by a band, in prolongation of the old pole, fasten the old front axle (which would become the rear one) by two bolts on each side of the semi-circular cog wheel, let the old rear axle (which would become the front one) work on a pivot, and between the axles, might be carried, with a little contrivance, whatever was required for transport.

A. F. O.

Digitized by Google

CAPTAIN OAKES' WAR ENGINE.

The War Engine for breaking Infantry Squares, invented by Captain Oakes, of the Madras Horse Brigade, Director of the Artillery Depot of Instruction. *See Plates 72 and 73.* *15th June*, 1848.

The object of the inventor of this machine, is to enable cavalry to do that, which they have hitherto failed in accomplishing, viz., to break infantry squares.

Its Description.

The machine is on four wheels, is propelled by two horses being harnessed close to the axle of the rear wheels, the distance between the front and rear axles, is just sufficient to admit of galloping room for the horses, and a seat for the guide in front of them; before the guide is a mantelet of sheet iron, musket proof, this extends from within 8 inches of the ground, to the height of 7½ feet, and is so proportioned, as effectually to screen the horses, driver, and guide, who are behind it. In front of the mantelet, and projecting two feet in advance of the front wheel, is the point of the pole, which is shod with iron; the wheels are of iron, and of 5 feet diameter.

Its Locomotive Capabilities.

The machine can be guided with the greatest ease, can be turned to either hand, without difficulty, can be propelled over any ground, which will admit of cavalry galloping thereon, has been tried over broken ground, consisting of ditches of 8 feet deep, with banks at an angle of between 20 and 30 degrees, and has travelled without inconvenience; it is propelled rapidly and easily with two horses.

The Dress and Arms of the Driver and Guide.

The driver who rides the near horse, and the guide who is seated in front of the horses, close to the rear of the front axle, both wear

Digitized by Google

a cuirass and a helmet, with a low crest and flowing mane, and are armed with a cavalry sword and with pistols.

The Harness and Horse Appointments.

The harness is nearly of the same pattern as that in use with the Madras Horse Artillery; the sword is attached to a ring on the near side of the cantle of the saddle by the upper ring of the scabbard; the pole chains and traces are so fixed, as to enable the driver and guide, to set the horses free from the machine in an instant, the off horse has also a saddle on him, in case of need, for the use of the guide; the driver and guide, if required to unhook and gallop away from the machine, can do so in a few seconds. Both saddles should be low in the cantle, with a pad behind and leathers; so constructed, as to admit of either horse, on an emergency, carrying double.

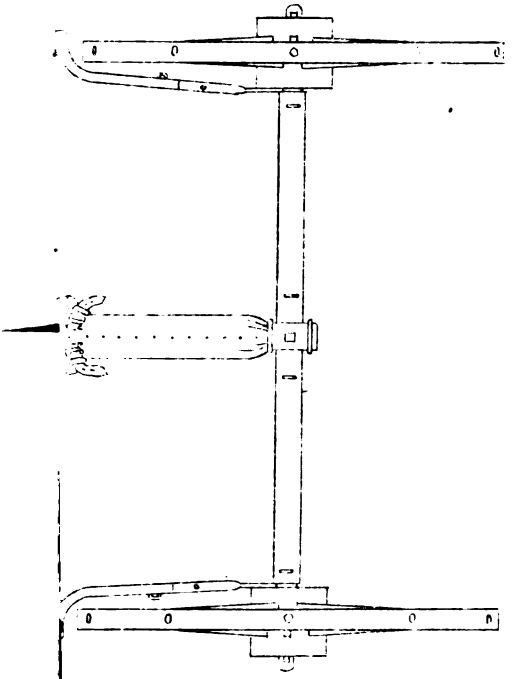
Its Application.

The machine should approach the square with a troop of cavalry, close to, and on each flank of its front wheels; when within a few yards of *charging distance*, the machine should be ordered to advance and charge, the command being so timed, as to enable it to reach the square a few seconds sooner than the cavalry, by which it is accompanied; the machine being irresistible, dashes through the centre of the face of the square, carrying destruction in its front and flanks, and proceeds onwards straight through the opposite face; the few seconds that would intervene between the order for the machine to advance, and the charge of the cavalry, would be occupied by the latter closing to the centre; this being done, the cavalry would follow immediately after the machine, advancing like lightning to the charge; they then retire by the outward flanks allowing the squadrons in reserve to charge in succession, and to retire in like manner, reforming at a convenient distance in rear to resume the attack if necessary: thus in the course of a few minutes, will the square be completely annihilated. The machine after passing through the *square*, makes a wide reverse and rapidly retires, or otherwise, according to previous order under the protection of cavalry.

Digitized by Google

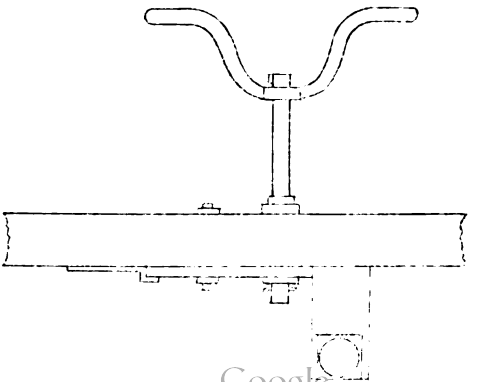
Plate 23.

yine.



ne.

Side Elevation.



Digitized by Google

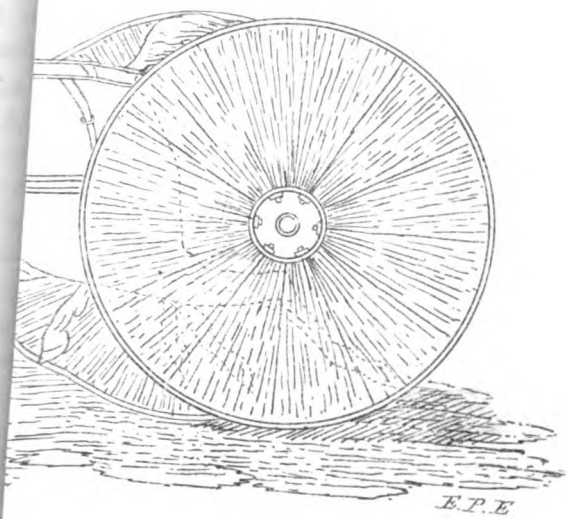
Printed by P P E P E

Digitized by Google

Plate 73.

ine

are.



E.P.E

Printed by F.D.

Digitized by Google

Digitized by Google

Military Force of France, Communicated by Captain Moberly, R. A. Sent to the Director by Captain C. C. Young, R. A.

A law passed in 1841 requires the maintenance in France at all times of a force amounting to 344,000, and not exceeding at any time a total of 500,000 fighting men.

Infantry.—100 regiments of the line and of light infantry of 3 battalions each, containing 7 companies per battalion, a grenadier company, a light company, and a depôt company inclusive. 10 battalions of infantry chasseurs of light infantry *par excellence*, each of 8 companies, two depôt companies included for battalions serving in Algeria. One regiment of Zouares allowed to enlist natives of Algeria, each battalion comprising 9 companies inclusive of a depôt company, 3 battalions of "Africa" light infantry, each of 8 service and 2 depôt companies. 12 discipline or police companies. One foreign legion comprising 2 regiments of 3 battalions of eight companies each.

Cavalry.—2 regiments of carbineers, 10 of cuirassiers, 12 of dragoons, 8 of lancers, 9 of hussars, each regiment consisting of 5 squadrons.

Artillery.—14 regiments, 10 of which consists of 14 batteries and 4 of 15, each regiment having its own depôt in addition. 1 regiment of pontooners of 12 companies, 12 companies of workmen, half a company of armourers, 6 corps of park train each of 8 companies; the strength of a company on the peace establishment is 96 men and 4 officers.

Engineers.—3 regiments, each of 8 companies, *viz.*, 7 of sappers and 1 of miners, besides which each regiment has 1 company of sapper leaders and 2 of artificers attached to it.

Gendarmerie.—26 legions, 1 is serving in Algeria. 1 additional legion of 4 companies of light gendarmerie is employed in Corsica; this arm consists both of horse and foot, the proportions of which cannot be correctly given. The muni-

Digitized by Google

cipal guard of Paris, horse and foot, consisting of about 1,600 men (all distinguished for good conduct or service in other corps, and providing, when mounted, their own horses, ranking amongst the finest, if not as the finest corps of troops existing,) and accoutred as were the old imperial guard of Napoleon.

One fire brigade *(Sapeurs Pompiers)* of 5 companies.

Veterans.—Are divided into 8 companies of non-commissioned officers, 10 of fusileers, 4 of cavalry, 13 of artillery, 1 of engineers, and 2 of gendarmerie.

General Service.—1 battalion of workmen of 10 companies and a depôt, 4 brigades of waggon train, each of 4 companies and a depôt, 4 companies of labourers being also attached to each brigade.

The reserve or dismissed men liable to be called on for further service are not included in the foregoing statement. They are reviewed twice a year. The war establishment contemplates 9 companies as the strength of an infantry battalion, depôt included, and fourth battalions to regiments were needed, also a sixth or extra squadron to the cavalry regiments. The war complement of artillery is left to the discretion of the minister of war. Each engineer regiment would obtain a ninth company of sappers and 2 depôt companies.

The park trains and pontooners would also form war depôts, and an addition of two extra companies would be made to each waggon brigade train.

Two regiments of mounted guides consisting of 6 squadrons, would be added to the army upon a war footing, for staff service.

On the 1st January, 1846, after the liberation of 51,071 men of the class of 1838, the active army had an effective of 3,714,766 men, of which 275,188 were in the corps at home, and 99,578 composing the army in Africa. The reserve reckoned at the same period, an effective of 82,869 men, (of which number 11,569, had already served,) not reckoning the 80,000

Digitized by Google

men of the class of 1845, who would be at the disposal of the Government only in the course of the month of July following.

Artillery of France, Communicated by Major Ross, R. H. A.

A Royal Ordonnance, dated 13th September, 1833, founded on the report of the then Minister of War, (Marshal Soult,) decreed the organization of the French artillery upon a new basis. By the then existing organization (5th August, 1829,) it was composed of 11 regiments, each regiment consisting of 3 batteries horse artillery, 6 field batteries, 7 foot artillery companies, and in time of war only, a depôt.

It would appear by this, that 33 horse artillery batteries and 66 field batteries could at once be sent into the field, but the report, after enumerating various objections to the system proposes that "*each regiment shall be composed of mounted batteries only*," and "the only thing then would be, to give on the peace establishment, a uniform composition for all the skeleton batteries, in such manner, that on occasion requiring it, they may receive the number of men and horses appropriated to the war complement, an operation similar to what is practised when it is deemed necessary to increase the strength of a cavalry regiment." It then goes on to say, that the number of regiments must be increased, and fixes it at 14.

Each regiment to be composed of an Etat-Major, a supernumerary section, (non-combatants, quarter-master, clerks and artificers, &c.,) not in the ranks (*Peloton hors Rang*,) 12 batteries and a depôt of chefs d'escadron, and 1 major.

The 4 first regiments to have 3 of the 12 batteries horse artillery, and the remaining 10; only 2 each; 32 batteries of this nature being deemed indispensably necessary.

The report proceeds to state "the necessity for a distinct corps, but dependant on the artillery, to provide for the duties of the parks, siege, and pontoon equipments, as well as for the

Digitized by Google

transport of all the munitions of war;" this waggon train (*Corps du Train des Parcs d' Artillerie*) to be a mere skeleton, but capable of great extension in case of war, and to be limited to what is strictly necessary for the instruction, as well as for *the service of the Arsenals* and the *schools of Artillery;* each squadron to be commanded by a superior officer, to be composed of an Etat-Major, a supernumerary section, 6 companies, and in time of war only a depôt. The report continues, "The 4032 draught horses will at once permit of being brought into the field, 336 guns and 336 waggons, drawn by 6 horses each, or 336 guns and 672 ammunition waggons, drawn by 4 horses each. Such would be the minimum of the resources of France in field artillery should war unexpectedly break out.

Peace Establishment, as adopted in 1833.

	Men.			Horses.		
					Of Troops.	
6 Squadrons Waggon Train.	Officers.	N. C. Officers and Soldiers.	Enfans de Troupe.	Of Officers.	Riding.	Draught.
6 Etats Major	30	30	0	48	30	0
6 Pelotons hors Rang	6	168	12	12	0	0
36 Companies	36	1080	72	36	144	576
Total..	72	1,278	84	96	174	576
14 Regiments.						
14 Etats Major	238	140	0	406	112	0
14 Pelotons hors Rang	14	714	28	0	0	0
36 Batteries Horse Artillery.	128	3,072	64	128	1,536	768
136 Field Batteries	544	13,056	272	544	1,360	3,264
14 Depôts	56	266	28	56	140	0
Total..	980	17,248	392	1,134	3,148	4,032
					3,322	4,608
General Total..	1,052	18,526	476	1,230	7,930	

In 1840, (15th November,) when war seemed imminent and the whole French army was increased, 32 batteries were added to the artillery force, the 4 first regiments receiving three additional, and the remaining 10, two each; 16 additional *Chefs d' Escadron* were named, and 12 additional companies of waggon train formed, the regiment of Pontooners

Digitized by Google

was at the same time increased, and placed on a better footing as below. (19th November, 1840.)

	War Establishment.		Peace Establishment.	
	Men.	Horses.	Men.	Horses.
Officers	66	156	61	—
Non-Commd. Officers and Soldiers.	1,551	—	873	—
Enfans de Troupe	13	—	13	—
Total..	1,630	156	947	—

Peace Establishment, Law of 1841.

	Officers.	N. C. Offs. and Men.	Enfans de Troupe.
14 Regiments, (4 of 15 Batteries each, and 10 of 14,) with a Depôt to each	1,124	20,320	456
6 Squadrons of Waggon or Park Train, each consisting of a Staff and 8 Companies	84	1,638	108
6 Companies Foot Artillery Veterans	24	1,200	—
1 Regiment Pontooners	61	873	13
12 Companies Artillery Artificers	48	840	24
1 Company Armourers	4	100	2
Total..	1,345	24,971	603

Establishment of Horses.

	Men.			Horses.		
	Officers.	N. C. Officers and Soldiers.	Enfans de Troupe.	Officers.	Riding.	Draught.
14 Regiments	1,124	20,320	456	1,294	3,468	4,800
6 Squadrons Waggon Train,	84	1,638	108	108	222	768
Total..	1,208	21,958	564	1,402	3,690	5,568

The 4,800 draught horses attached to the 14 regiments, give 400 guns and 400 waggons drawn by 6 horses each, or 400 guns and 800 waggons drawn by 4 horses each.

Such was the peace establishment according to the law of 1841, but by the official return, (August, 1846,) it would appear that a considerable increase must have occurred, as the number of N. C. officers and men then amounted to 29,293.

Digitized by Google

Officers, Non-Commissioned Officers and Soldiers of Batteries.

	Horse Artillery.				Field Batteries.				Foot Arty
	War Establishment.		Peace Establishment.		War Establishment.		Peace Establishment.		
	Men.	Horses.	Men.	Horses.	Men.	Horses.	Men.	Horses.	Men.
1st Captain,	1	3	1	2	1	3	1	2	1
2d Captain,	1	3	1	2	1	3	1	2	1
1st Lieutenant,	1	2	1	1	1	2	1	1	1
2d Lieutenant,	1	2	1	1	1	2	1	1	1
Officers	4	10	4	6	4	10	4	6	4
Adjutant,	1	1	—	—	1	1	—	—	—
Serjeant Major,	1	1	1	1	1	1	1	1	1
Serjeants,	8	8	6	6	8	8	6	3	8
Farrier (Pay Serjeant,)	2	2	1	1	2	2	1	1	1
Brigadiers (Corporals,)	12	12	6	6	12	6	6	3	12
Artificers (Fireworkers,)	6	6	6	—	6	—	6	—	6
Gunners.. 1st Class	28	66	16	32	24	—	16	—	66
Gunners.. 2d Class	54		24		36		24	—	100
Drivers... 1st Class	40	156	10	24	44	180	10	24	—
Drivers... 2d Class	58		16		66		16		
Artificers in Wood and Iron..	4	—	4	—	4	—	4	—	4
Farriers	3	3	2	—	3	3	2	—	—
Collar Makers,	2	—	1	—	2	—	1	—	—
Trumpeters,	3	3	3	2	3	3	3	2	2
Grand Total..	226	268	100	78	216	214	100	40	204
Enfans de Troupe	2	—	2	—	2	—	2	—	2

The French Light Field Artillery.

To the Editor of the Delhi Gazette,

"La science de la guerre est dans les Jambes?"
Marecha de Saxe.

Sir,

As a war between France and some of her continental neighbours will be an almost certain consequence of the late revolution, a few remarks, on the equipment of the French Light Field Artillery may not be unacceptable to those who take an interest in European politics.

It will not, I trust, be thought that I overrate the importance of artillery. Perhaps indeed I somewhat undervalue its actual effects on the field of battle; but, as the movements of an army must be greatly affected by the ability or inability of its artillery to make long marches, and to overcome difficul-

* Proceedings of the Royal Institution.

Digitized by Google

ties of ground; it is no exaggeration to say, that the efficiency of the light field batteries is of vital importance to the success of a campaign.

The guns commonly used by the French at the commencement of the wars of the first revolution, were 8 pdrs. of 30 cwt. drawn by teams of 4 horses and 4 pdrs. of 19 cwt. drawn by teams of 4 horses but both these pieces were condemned in 1803; the 8 pdr. because it was too heavy, and the 4 pdr. because its effect was paltry.

A six pounder, which, with carriage limber and all things requisite for service, weighed about 25 cwt. was substituted for both the old classes of light field ordnance.

The 8 and 4 pounders, of necessity continued in use, for many years after they had been condemned; but six pounders were most commonly used in the great battles of the empire; and their number increased every year, until the downfall of Napoleon and the restoration of the Bourbons, when the 8 pounder was again adopted and the 6 pounder entirely displaced.

The team of the 8 pounder was increased (from 4) to six horses.*

In 1827, the adoption of the English system was recommended by a committee of French artillery officers, who gave four 8 pounder guns† and two 64 pounder howitzers to every troop and battery of field artillery. The metal of the 8 pounder was not increased, nor was the howitzer made heavier than the gun, but the great weight of the new limber and of the ammunition carried on it made the total amount behind each team nearly equal to 36 cwt. exclusive of forage, and of the men who in action were placed on the ammunition box of the limber. The teams of horses were not increased, and a weight, which, in the English service, is found to require 8 horses, was (and still is) drawn, in France, by six horses only.

* In 1801 the price of a horse of the light field artillery was 460 francs, of other artillery horses only 360 francs.

† The calibre of the French 8 pounder is nearly equal to that of the English 9 pounder, if our memory deceives us not.—Ed.

Digitized by Google

The most strenuous opposition to this great increase of weight was offered by many experienced officers, who declared in unqualified terms, that an army equipped with such an artillery, would be unable to execute those rapid marches, and difficult combinations, by which so much honor had formerly been gained. The committee however carried their point and the French (in 1845,) had, and I believe now have

32 eight pounder troops of horse artillery, and
168 eight pounder light field batteries, comprising
800 eight pounder guns, and
400 twenty-four pounder howitzers.

The war establishment of horses for a troop of horse artillery is	238
The peace establishment	46
The war establishment of each field battery	208
The peace establishment	40

I do not know how many troops and batteries are at present on the war establishment, nor is the point of much importance, my object being merely to show, that although a foreign army, invading France, would encounter a most formidable force of field artillery, yet that the French armies, owing to the great weight of their field guns, will be less formidable, as invaders than they were in the wars of the republic and of the empire.

Although in common with many experienced officers, who have written upon the subject, I think that the French acted imprudently in arming all their light field batteries with 8 pounders; and, although, I feel assured that, in service of any continuance, their teams of six horses will be found unequal to the work they are expected to perform; yet, in justice to the late French Government I must say, that they spared no expense to obtain efficient cattle for their artillery. The price allowed for an artillery horse, whether of a troop or a battery, is 800 francs, while that of a cavalry charger, is only 600.*

OTTIS.

* *U. S. Gazette, 30th May, 1848.*

Digitized by Google

The Bowie Knife and its Inventor.

This instrument was devised by Colonel James Bowie, an American, and a man of desperate valour. He considered, and apparently with justice, too, that in close fighting, a much shorter weapon than the sword ordinarily in use, but still *heavy* enough to give it sufficient force, and, at the same time, contrived to cut and thrust, would be far preferable, and more advantageous to the wearer. He accordingly invented the short sword, or knife, which has since gone under his name. It is made of various sizes; but the best, I may say, is about the length of a carving knife—case perfectly straight in the first instance, but greatly rounded at the end on the edge side; the upper edge at the end for the length of about two inches, is ground into the small segment of a circle and rendered sharp; thus leaving an apparent curve of the knife, although in reality the upturned point is not higher than the line of the back. The back itself gradually increases in weight of metal as it approaches the hilt, on which a small guard is placed. The Bowie knife, therefore, has a curved, keen point; is double edged for the space of about a couple of inches of its length, and when in use, falls with the weight of a bill hook. Bowie went to Texas during the troubles which preceded the independence of that country,—and was lying sick in bed at the fortress of the Alamo, when, on the 6th of March, 1836, it was stormed by Santa Anna and taken. Bowie was murdered there upon his pillow. The hand that formed the dreadful knife could no longer wield it.*

The Trees most affected by Lightning.

Fig trees and cedars are rarely struck with lightning; the beech, larch-fir, and chesnut, are obnoxious to it; but the trees which attract it most are the oak, yew, and Lombardy poplar; whence it follows that the last are the trees most

* Mec. Mag., March, 1847.

Digitized by Google

proper to be placed near a building, since they will act as so many lightning conductors to it. Again, the electric fluid attacks in preference such trees as are verging to decay by reason of age or disease.*

Comparative View of the Casualties in the Modern Battles of India as compared with that of Waterloo.

	Total number of Troops in action.	Killed and wounded.	Proportionin round numbers.
Waterloo, 1815, Duke of Wellington, -	72,000	1,1960	1 in 6
Assaye, 1803, Duke of Wellington, -	4,500	1,541	1 — 3
Laswarry, 1803, Lord Lake, - - -	6,500	900	1 — 7½
Mahidpoor, 1817, Sir T. Hyslop, -	4,000	800	1 — 6
Meanee, 1843, Sir C. Napier, - -	2,800	256	1 — 11
Ferozeshah and Moodkee, 1845, Sir H. Gough, - - - - - - -	18,500	3,287	1 — 6†

On the Induction of Atmospheric Electricity on the Wires of the Electric Telegraph. By Professor Joseph Henry.

The action of the electricity of the atmosphere on the wires of the electrical Telegraph is at the present time a subject of much importance, both on account of its practical bearing, and the number of purely scientific questions which it involves. I have accordingly given due attention to the letter referred to me, and have succeeded in collecting a number of facts in reference to the action in question, some of these are from the observations of different persons along the principal lines, and others from my own investigations during a thunder storm on the 19th of June, when I was so fortunate as to be present in the office of the telegraph in Philadelphia, while a series of very interesting electrical phenomena was exhibited. In connexion with the facts derived from these sources, I must ask the indulgence of the society, in frequently referring, in the course of this communication, to the results of my previous investigations in dynamic electricity,

* Mec. Mag., April, 1847. † Naval and Military Gazette.

Digitized by Google

accounts of which are to be found in the Proceedings and Transactions of this Institution.*

From all the information on the subject of the action of the electricity of the atmosphere on the wires of the telegraph, it is evident that effects are produced in several different ways.

1. The wires of the telegraph are liable to be struck by a direct discharge of lightning from the clouds, and several cases of this kind have been noticed during the present season. About the 20th May the lightning struck the elevated part of the wire, which is supported on a high mast at the place where the telegraph crosses the Hackensack river. The fluid passed along the wire each way, from the point which received the discharge, for several miles, striking off at irregular intervals down the supporting poles, at each place where the discharge to a pole took place, a number of sharp explosions were heard in succession, resembling the rapid reports of several rifles. During another storm, the wire was struck in two places in Pennsylvania, on the route between Philadelphia and New York; at one of these places twelve poles were struck, and at the other eight. In the latter case the remarkable fact was observed, that every other pole escaped the discharge; and the same phenomenon was observed, though in a less marked degree, near the Hackensack river. In some instances the lightning has been seen coursing along the wire in a stream of light; and in another case it is described as exploding from the wire at certain points, though there were no bodies in the vicinity to attract it from the conductor.

In discussing these and other facts to be mentioned hereafter, we shall, for convenience, adopt the principles and language of the theory which refers the phenomena of electricity to the action of a fluid, of which the particles repel each other, and are attracted by the particles of other matter. Although it cannot be affirmed that this theory is an actual representation of the cause of the phenomena as they are produced in nature, yet it may be asserted that it is, in the

* American Philosophical Society.

Digitized by Google

present state of science, an accurate mode of expressing the laws of electrical action, so far as they have been made out; and that though there are a number of phenomena, which have not as yet been referred to this theory, there are none which are proved to be directly at variance with it.

That the wires of the telegraph should be frequently struck by a direct discharge of lightning, is not surprising, when we consider the great length of the conductor, and consequently the many points along the surface of the earth through which it must pass peculiarly liable to receive the discharge from the heavens. Also from the great length of the conductor, the more readily must the repulsive action of the free electricity of the cloud drive the natural electricity of the conductor to the further end of the line, thus rendering more intense the negative condition of the nearer part of the wire, and consequently increasing the attraction of the metal for the free electricity of the cloud. It is not however probable that the attraction, whatever may be its intensity, of so small a quantity of matter as that of the wire of the telegraph, can of itself produce an electrical discharge from the heavens; although, if the discharge were started by some other cause, such as the attraction of a large mass of conducting matter in the vicinity, the attraction of the wire might be sufficient to change the direction of the descending bolt, and draw it in part or whole to itself. It should also be recollected, that, on account of the perfect conduction, a discharge on any part of the wire must affect every other part of the connected line, although it may be hundreds of miles in length.

That the wire should give off a discharge to a number of poles in succession, is a fact I should have expected, from my previous researches on the lateral discharge of a conductor transmitting a current of free electricity. In a paper on this subject presented to the British Association in 1837, I showed that when electricity strikes a conductor explosively, it tends to give off sparks to all bodies in the vicinity, however intimately the conductor may be connected with the earth.

Digitized by Google

In an experiment in which sparks from a small machine were thrown on the upper part of a lightning-rod, erected in accordance with the formula given by the French Institute, corresponding sparks could be drawn from every part of the rod, even from that near the ground. In a communication since made to this Society, I have succeeded in referring this phenomenon to the fact, that during the transmission of a quantity of electricity along a rod, the surface of the conductor is charged in succession, as it were, by a wave of the fluid, which, when it arrives opposite a given point, tends to give off a spark to a neighbouring body, for the same reason that the charged conductor of the machine gives off a spark under the same circumstances.

It might at first be supposed that the redundant electricity of the conductor would exhaust itself in giving off the first spark, and that a second discharge could not take place; but it should be observed, that the wave of free electricity in its passage, is constantly attracted to the wire by the portion of the uncharged conductor which immediately precedes its position at any time; and hence but a part of the whole redundant electricity is given off at one place the velocity of transmission of the wave as it passes the neighbouring body, and its attraction for the wire, preventing a full discharge at any one place. The intensity of the successive explosions is explained by referring to the fact, that the discharge from the clouds does not generally consist of a single wave of electricity, but of a number of discharges along the same path in rapid succession, or of a continuous discharge which has an appreciable duration; and hence the wire of the telegraph is capable of transmitting an immense quantity of the fluid thus distributed over a great length of the conductor.

The remarkable facts of the explosions of the electricity into the air, and of the poles being struck in interrupted succession, find a plausible explanation in another electrical principle which I have established, namely, in all cases of the disturbance of the equilibrium of the electrical plenum, which

Digitized by Google

we must suppose to exist throughout all terrestrial space, the state of rest is attained by a series of diminishing oscillations. Thus in the discharge of a Leyden jar, I have shown that the phenomena exhibited cannot be explained, by merely supposing the transfer of a quantity of fluid from the inner to the outer side of the jar; but in addition to this we are obliged to admit the existence of several waves, backwards and forwards, until the equilibrium is attained. In the case of the discharge from the cloud, a wave of the natural electricity of the metal, is repelled each way from the point on which the discharge falls, to either end of the wire, is then reflected, and in its reverse passage meets in succession the several waves which make up the discharge from the cloud. These waves will therefore interfere at certain points along the wire, producing, for a moment waves of double magnitude, and will thus enhance the tendency of the fluid at these points to fly from the conductor. I do not say that the effects observed were actually produced in this way; I merely wish to convey the idea that known principles of electrical action might, under certain circumstances, lead us to anticipate such results.

2. The state of the wire may be disturbed by the conduction of a current of electricity, from one portion of space to another, without the presence of a thunder cloud; and this will happen in case of a long line, when the electrical condition of the atmosphere which surrounds the wire at one place, is different from that at another. Now it is well known that a mere difference in elevation is attended with a change in the electrical state of the atmosphere. A conductor elevated by means of a kite, gives sparks of positive electricity in a perfectly clear day; hence if the line of the telegraph passes over an elevated mountain ridge, there will be continually, during clear weather, a current from the more elevated to the lower points of the conductor.

A current may also be produced in a long level line, by the precipitation of vapour in the form of fog at one end,

Digitized by Google

while the air remains clear at the other; or by the existence of a storm of rain or snow at any point along the line, while the other parts of the wire, are not subjected to the same influence.

Currents of sufficient power to set in motion the marking machine of the telegraph have been observed, which must have been produced by some of these causes. In one case the machine spontaneously began to operate without the aid of the battery, while a snow storm was falling at one end of the line, and clear weather existed at the other. On another occasion a continued stream of electricity was observed to pass between two points at a break in the wire, presenting the appearance of a gas light almost extinguished. A constant effect of this kind indicates a constant accession of electricity at one part of the wire, and a constant discharge at the other.

3. The natural electricity of the wire of the telegraph is liable to be disturbed by the ordinary electrical induction of a distant cloud. Suppose a thunder cloud, driven by the wind in such a direction as to cross one end of the line of the telegraph at the elevation, say of a mile; during the whole time of the approach of the cloud to the point of its path directly above the wire, the repulsion of the redundant electricity with which it is charged, would constantly drive more and more of the natural electricity of the wire to the further end of the line, and would thus give rise to a current. When the cloud arrived at the point nearest to the wire, the current would cease for a moment; and as the repulsion gradually diminished by the receding of the cloud, the natural electricity of the wire would gradually return to its normal state, giving rise to a current in an opposite direction. If the cloud were driven by the wind parallel to the line of the telegraph, a current would be produced towards each end of the wire, and these would constantly vary in intensity with the different positions of the cloud. Although currents produced in this way may be too feeble to set in motion the marking

Digitized by Google

apparatus, yet they may have sufficient power to influence the action of the current of the battery so as to interfere with the perfect operation of the machine.

4. Powerful electrical currents are produced in the wires of the telegraph by every flash of lightning which takes place within many miles of the line, by the action of dynamic induction; which differs from the action last described, in being the result of the influence of electricity *in motion* on the natural electricity of the conductor. The effect of this induction, which is the most fruitful source of disturbance, will be best illustrated by an account of some experiments of my own, presented to the Society in 1843. A copper wire was suspended by silk strings around the ceiling of an upper room, so as to form a parallelogram of about sixty feet by thirty on the sides; and in the cellar of the same building, immediately below, another parallelogram of the same dimensions was placed. When a spark from an electrical machine was transmitted through the upper parallelogram, an induced current was developed in the lower one, sufficiently powerful to magnetize needles, although two floors intervened, and the conductors were separated to the distance of 30 feet. In this experiment, no electricity passed through the floors from one conductor to the other; the effect was entirely due to the repulsive action of the electricity in motion in the upper wire on the natural electricity of the lower. In another experiment, two wires, about 400 feet long, were stretched parallel to each other between two buildings; a spark of electricity sent through one produced a current in the other, though the two were separated to the distance of 300 feet; and from all the experiments, it was concluded that the distance might be indefinitely increased, provided the wires were lengthened in a corresponding ratio.

That the same effect is produced by the repulsive action of the electrical discharge in the heavens, is shown by the following modification of the foregoing arrangement. One of the wires was removed, and the other so lengthened at one end, as to pass into my study, and thence through a cellar win-

Digitized by Google

dow into an adjacent well. With every flash of lightning which took place in the heavens, within at least a circle of twenty miles around Princeton, needles were magnetized in the study by the induced current developed in the wire. The same effect was produced by soldering a wire to the metallic roof of the house and passing it down into the well; at every flash of lightning a series of currents in alternate directions was produced in the wire.

I was also led, from these results, to infer that induced currents must traverse the line of a railroad, and this I found to be the case. Sparks were seen at the breaks in the continuity of the rail with every flash of a distant thunder-cloud.

Similar effects, but in a greater degree must be produced on the wire of the telegraph by every discharge in the heavens, and the phœnomena which I witnessed on the 19th of June, in the Telegraph Office in Philadelphia were, I am sure, of this kind. In the midst of the hurry of the transmission of the congressional intelligence from Washington to Philadelphia, and thence to New York, the apparatus began to work irregularly. The operator at each end of the line announced at the same time a storm at Washington and another at Jersey City. The portion of the circuit of the telegraph which entered the building, and was connected with one pole of the galvanic battery, happened to pass within the distance of less than an inch of the wire which served to form the connexion of the other pole with the earth, across this space, at an interval of every few minutes, a series of sparks in rapid succession was observed to pass; and when one of the storms arrived so near Philadelphia that the lightning could be seen, each series of sparks was found to be simultaneous with a flash in the heavens. Now we cannot suppose for a moment that the wire was actually struck at the time each flash took place; and indeed it was observed that the sparks were produced when the cloud and flash were at the distance of several miles to the east of the line of the wire. The inevitable conclusion is, that all the exhibition of electrical phœnomena witnessed during

Digitized by Google

the afternoon was purely the effect of induction, or the mere disturbance of the natural electricity of the wire at a distance, without any transfer of the fluid from the cloud to the apparatus.

The discharge between the two portions of the wire continued for more than an hour, when the effect became so powerful, that the Superintendent, alarmed for the safety of the building, connected the long wire to the city gas-pipes, and thus transmitted the current silently to the ground. I was surprised at the quantity and intensity of the current; it is well known, that to affect a common galvanometer with ordinary electricity, requires the discharge of a large battery; but such was the quantity of the induced current exhibited on this occasion, that the needle of an ordinary vertical galvanometer, with a short wire, and apparently of little sensibility, was moved several degrees.

The pungency of the spark was also, as might have been expected very great. When a small break was made in the circuit, and the parts joined by the fore-finger and thumb, the discharge transmitted through the hand affected the whole arm up to the shoulder. I was informed by the Superintendent, that on another occasion a spark passed over the surface of the spool of wire, surrounding the legs of the horse-shoe magnet at right angles to the spires; and such was its intensity and quantity, that all the wires across which it passed, were melted at points in the same straight line, as if they had been cut in two by a sharp knife.

The effects of the powerful discharges from the clouds may be prevented in a great degree, by erecting at intervals along the line, and aside of the supporting poles, a metallic wire, connected with the earth at the lower end, and terminating above at the distance of about half an inch from the wire of the telegraph. By this arrangement the insulation of the conductor will not be interfered with, while the greater portion of the charge will be drawn off. I think the precaution of great importance at places where the line crosses a river, and

Digitized by Google

is supported on high poles; also in the vicinity of the office of the telegraph, where a discharge, falling on the wire near the station, might send a current into the house of sufficient quantity to produce serious accidents. The fate of Professor Richman, of St. Petersburgh, should be recollected, who was killed by a flash from a small wire, which entered his house from an elevated pole while he was experimenting on atmospheric electricity.

The danger, however, which has been apprehended from the electricity leaving the wire and discharging itself into a person on the road, is, I think, very small; electricity of sufficient intensity to strike a person at the distance of eight or ten feet from the wire, would in preference, be conducted down the nearest pole. It will, however, in all cases be most prudent to keep at a proper distance from the wire during the existence of a thunder-storm in the neighbourhood.

It may be mentioned as an interesting fact, derived from two independent sources of information, that large numbers of small birds have been seen suspended by the claws from the wire of the telegraph. They had in all probability been instantaneously killed, either by a direct discharge, or an induced current from a distant cloud, while they were resting on the wire.

Though accidents to the operators, from the direct discharge, may be prevented by the method before mentioned, yet the effect on the machine cannot be entirely obviated; the residual current which escapes the discharge along the perpendicular wires, must neutralize for a moment the current of the battery, and produce irregularity of action in the apparatus.

The direct discharge from the cloud on the wire is, comparatively, not a frequent occurrence, while the dynamic inductive influence must be a source of constant disturbance during the season of thunder-storms; and no other method presents itself to my mind at this time for obviating the effect, but that of increasing the size of the battery, and

Digitized by Google

diminishing the sensibility of the magnet, so that at least the smaller induced currents may not be felt by the machine. It must be recollected that the inductive influence takes place at a distance through all bodies, conductors and non-conductors; and hence no coating that can be put upon the wire will prevent the formation of induced currents.

I think it not improbable, since the earth has been made to act the part of the return conductor, that some means will be discovered for insulating the single wire beneath the surface of the earth; the difficulty in effecting this, is by no means as great as that of insulating two wires, and preventing the current striking across from one to the other. A wire buried in the earth would be protected in most cases from the effect of a direct discharge; but the inductive influence would still be exerted, though perhaps in a less degree.

The wires of the telegraph are too small and too few in number to affect, as some have supposed, the electrical condition of the atmosphere, by equalizing the quantity of the fluid in different places, and thus producing a less changeable state of the weather. The feeble currents of electricity which must be constantly passing along the wires of a long line, may, however, with proper study, be the means of discovering many interesting facts relative to the electrical state of the air over different regions.*

Report on the state of Education in the Polytechnic School at Paris prepared at the request of James Heywood, F. R. S., by an English Resident in Paris.

The Polytechnic School of Paris is the principal Education Institution in which pupils are prepared for the public service, in the departments of the Artillery, Engineering, and the construction of roads and bridges in France.

A severe preliminary examination is required from all the

* Repertory of Patent Inventions, May and June, 1847.

Digitized by Google

candidates who are desirous of admission into the Polytechnic School.

Two years' study are required from each of the pupils in the school, and the course of study consists, practically, of a continual series of examinations, which are often limited to particular branches of Mathematical Science, and are followed by more general examinations at the end of each Academical year.

Public competition forms a part of the regulations for the entrance examination in the Polytechnic School, and no one can be admitted to this competition without having previously proved, that he is either French by birth, or French by naturalization, and that he is between sixteen and twenty years of age; soldiers only are permitted to enjoy a special exemption from this last rule, and they may be admitted to the competition, provided they have not attained their twenty-fifth year.

The subjects of the entrance examination include Arithmetic, Algebra, Plane and Descriptive Geometry, Plane and Spherical Trigonometry, Logarithms, Conic Sections, and Statics, exercises are also given in drawing from a model of the human figure, and in Architectural coloured drawings; and the candidates are further expected to translate a passage from a Latin author, to write a French essay on a given subject, to work a Trigonometrical question, and to compose a Mathematical paper on some given problem, or on some other Mathematical subject. Candidates are informed that all the foregoing subjects of the examination are equally obligatory upon them.

At the end of each Academical year, the pupils of the school are subjected to severe examinations in Analytical Geometry, Mechanics, Physics, Chemistry, Descriptive Geometry, the description and effect of machines, Architecture, and several of the higher branches of Algebra and Mathematics.

Drawing and French composition are included among the

Digitized by Google

subjects of study, and in the second year, the German language receives a portion of the attention of the students. A professorship of English was established in the school in 1830, at the same time the German professorship, and both these important languages were taught in the school until the autumn of 1840.

The annual payment, or "pension," for education in the Polytechnic School is only 1,000 francs, or 40£, and there are also twenty-four bursarships, of 1,000 francs each per annum, of which twelve are placed at the disposal of the Minister of War, eight belong to the Minister of the Interior, and four to the Minister of the Marine, for the students.

No pupil is, however, allowed to receive either a bursarship, or a half-bursarship, unless his name has been included in the first two-thirds of the admission list, and unless he has previously addressed a request for this emolument at the time of inscribing his name.

A strict system of Military discipline is maintained in the school; duelling is forbidden, under pain of expulsion to both parties, if a challenge is accepted; games of chance are illegal, as well as smoking; and no books, printed papers, or drawings are allowed to be introduced, without special leave. Unconditional obedience to every command of the superior officers of the school, is a fundamental rule of the Institution; the pupils are ordered on all occasions to salute their officers; they are required always to appear in their uniform, both in and out of school, and they are not allowed to hold or form any Society, or secret deliberation, or to print any thing in any periodical publication; and they must not even be present at any ceremony of any body or association, without the special permission of the commandant of the school.

Any pupil who remains absent from the school for three days, without communicating the cause to the commandant, ceases thereby to belong to the school. Two days only are allowed in each week on which the pupils may go out into the town, on Sunday, from the termination of the Military

Digitized by Google

parade at a quarter-past 9 in the morning, until 10 at night; and on Wednesday, from half-past 2 in the afternoon, until half-past 8 P. M. in summer, and 9 in winter. On these two days, the parents and guardians of the pupil, and persons furnished with permissions from them, are allowed to see the pupils in the parlour of the school, from 3 P. M. to a quarter before 5 P. M.

The pupils draw by lot for the seats which they occupy in the lecture-rooms, on first entering the school, and they always retain the same seats.

Exact notes are kept of their behaviour as well as of their proficiency, and marks of credit are granted to them accordingly.

A large staff of officers, examiners, and professors is maintained in the school, among whom are the well known names of Bourdon and Gay—Lussac: a certain number of extra masters are also privileged to give lessons in fencing, dancing, and music, and the school society is supplied with a Physician, a Surgeon, Assistant Surgeons, and numerous subordinate officers.

All the officers, including the commandant of the school, receive the full pay belonging to their rank, as well as one-third in addition to their pay, and the whole of the salaries are paid to the officers and others out of the funds of the school, which are included in the budget of the minister of war.

No ecclesiastical control is exercised over the students in the school, and no distinctions are made on account of religious opinions; persons of any denomination are admitted into the school, and in fact, the pupils are left entirely to themselves with respect to religion. The pupils are divided into four companies, to each of which are attached several sub-officers, out of their own body. They hold their rank only for one year, subject to re-appointment, and their promotion is considered as a mark of honourable distinction.

All orders of the superior officers are conveyed to the pu-

Digitized by Google

pils of each company through these sub-officers, who are further responsible for the good conduct of their comrades, and are liable to be punished for them; the sub-officers of the school also wear the same gold chevrons on their uniform, which distinguish the sub-officers of the same grade in the army. Those pupils who do not pass the examinations with credit at the end of the first year, cannot go up into the second year; and a similar failure at the end of another year, or even neglect during the daily examinations of the lectures, would cause them to be immediately dismissed from the school.

The place which they occupy at the end of the second year in the examinations, determines their order of admission into the public service; and as only very few are annually rejected, it may be said, that in general, the success of a candidate in the final examinations is always followed by a commission in the Artillery, the Engineers, the bridges and highways, the Navy, or in some other department of the public service.

On the first of April, 1840, there were 271 pupils in the Polytechnic School, of whom 139 were in the first year, and 132 in the second year: of the first year men, four only had been recommended to pass a second year, in the junior division of the school, as they were not yet sufficiently advanced to enter on the second year's course of study: and in the second year, eight had been authorized to remain an additional year in the division, for various reasons.

Of the total number of 271 pupils, 56 were from the department of the Seine, in which Paris is situated, 208 from other French departments, 2 from French colonies, 2 of British parents, 1 from Switzerland, 1 from Saxony, 1 from Trebizond.

Besides these regular pupils, authorizations had been granted by the minister of war to twenty-six young men, who were not pupils of the school, to attend the lectures, viz., sixteen in the division of the first year, and ten in the divi-

Digitized by Google

sion of the second year. These voluntary students were of various nations:—8 French, 1 English, 1 American, 2 Swiss, 3 Italian, 2 Greek, 1 Spanish, 2 Russian, 1 Norwegian, 1 Hessian, 1 Wertemberger, 2 Portuguese, and 1 Brazalian.

The body of professors is always recruited by young men of the greatest promise, selected either from the school itself, or from the most distinguished scientific institutions of the country; the general course of the studies is superintended by a council of instruction, and the whole system is subject to the constant supervision of a council of improvement: these two councils are formed from the principal officers of the school, and other men of science, and to their vigilance and able direction the Polytechnic School is largely indebted for its efficiency.

A council of discipline watches over the internal regulations of the school, and the whole establishment is under the special jurisdiction and authority of the minister of war.*

I.—Extracts from a Treatise on Artillery. Published in the "Journal des Sciences Militaires."—Communicated by Major C. C. Young, Royal Artillery, Tome, 3, No. 8. Translated from the French by Major P. J. Begbie, Madras Artillery.

On Recoil.

137. In order to have a correct idea of the reasons under the first head, it is necessary to examine with care the causes of the recoil of ordnance. The recoil depends principally upon the weight of the ball, the strength of the charge, the elevation, the length, and weight, of the gun and of the carriage.

Weight of the Ball.

When the charge ignites, it acts with equal force on the bottom of the bore as on the ball. But, as the weight of the gun and carriage taken together is about three or four hun-

* Advt. of Science, 1841.

Digitized by Google

dred times greater than that of the ball, it is evident that the motion imparted to the first ought to be slower than that of the other in the same proportion.

Charge Resistance of the Atmosphere.

The ball is not the sole cause of the recoil of the piece. A gun, loaded with blank cartridge, recoils also more or less in proportion to the strength of the charge.

The atmosphere, resisting by its expansion the elastic fluid generated by the inflamed powder, may thus be considered as a body, which requires to be displaced. If the piece be shotted, the resistance to the ball is superadded. When the charges are small, as the expansion of the elastic fluid is then gradual, the atmospheric resistance is also weak; but, in heavy charges, this expansion being exceedingly rapid, the resistance of the atmosphere, which increases, as we know, more than the square of velocity, becomes likewise very considerable.

Length of the Piece.

The recoil also depends on the length of the piece. The longer it is, the longer does the elastic fluid, disengaged from the powder, act against the ball, and consequently against the gun itself.

II.—Extract from Journal des Sciences Militaires—Tome 3, No. 9. Course of Instruction for Artillery Officers in Cannon Foundaries.

60. The want of durability of siege and garrison guns has caused researches to be made at different periods as to the best mode of enhancing the hardness, of the metal, without injuring its tenacity.

61. For a considerable period, zinc has been combined with an alloy of brass and copper, but no real and acknowledged advantage has resulted from the employment of this metal in the construction of ordnance. The zinc possesses moreover the disadvantage of volatizing, the consequence of which is

Digitized by Google

that in successive castings, the same bronze is destined to undergo a continual alteration in its original constituent parts, and a more rapid decay than that of the ordinary alloy.

62. Several attempts have been made to combine brass with iron, but always unsuccessfully, when the operation has been conducted on a large scale. In 1780, M. Bréget, an Artillery Officer, imagined that he had succeeded in amalgamating iron and brass, by the aid of a metal, zinc. He did so, on a small scale, but failed when he came to a large one. The zinc was nearly entirely dissipated, and the whole of the iron remained at the bottom of the furnace.

In 1816 the Russians employed iron in their foundries to a very great extent. They carried it as far as to 30 per cent. of the bronze; but an analysis of their alloy demonstrated that it did not contain more than 2 or 3 per cent. of iron, and not the slightest trace of brass.

In 1817, *M. le chef d' escadron* Dussaussoy made use of iron in the form of sheet tin, and succeeded in uniting about 1½ per cent. of this metal with 100 of bronze; but, this experiment, having been conducted only on a limited scale, we have no means of judging what would have been the result upon a larger one. Lastly a committee was established in 1825 at Douay, for the purpose of making fresh experiments. It succeeded remarkably well in amalgamating iron and bronze, but only in a very small quantity. Guns of all calibres were cast of this alloy and generally presented a very honey-combed appearance, some of the flaws penetrating through the bore, which made the serving of them very dangerous, and further they could not stand a very light proof, nevertheless, as the labors of this committee may be interesting under a metallurgical view, we will give a concise analysis of them.

As iron does nos fuse under 12,000 degrees of the centigrade, and bronze not under 18,000, the former cannot be cast at once by projection into a bronze bath: this can be effected however, by means of a compound preparatory alloy of three parts of iron and four of pewter, this last metal being the

Digitized by Google

only real solvent of the first. In order to compound this alloy, the iron, cut into small fragments, is put into crucibles on a blast furnace. On its attaining a reddish white heat, a quantity of pewter, equal to two-thirds of its weight, is thrown in, and the whole is covered with a layer of pounded charcoal, about the 13th part of a metre (3 inches) thick. A strong blast is then given to the furnace, and when the iron begins to fuse, a second quantity of the same weight of pewter is then added, after which the operation is continued by keeping up the fire, and agitating the mass from time to time until it becomes perfectly liquid, and no particle of iron is to be found therein, either in a solid or clammy state. Finally, it is run into either plates or pigs, which are easily reduced to fragments, this alloy being very fragile and brittle.

The quantity of iron may be increased even up to one-half, instead of $\frac{1}{4}$; but, with this proportion the binary alloy is very difficult to cast, when projected into the bronze bath. The ternary alloy is obtained by casting in the ordinary method, the copper and the bronze in a furnace appropriated for the casting of guns; when the bath is sufficiently liquid and frothing, the fire is made intense, and the binary alloy, reduced to small fragments, is thrown in, the process of stirring and mixing it, is gone through *de novo:* the fire being raised to the highest possible pitch of intensity, the metal is run, care being taken to keep up the heat to the last. By this process, we do not succeed in obtaining an amalgamation of more than 2 or 3, or at the very outside, 4 per cent. of iron to the bronze, however great may have been the proportion of the binary alloy used in the charging of the furnace. In these experiments cast iron was substituted for malleable, but without obtaining more favorable results.

63. The committee on founding also made some attempts to combine iron and antimony with bronze. In consequence, a 24 pounder gun and a mortar of 32 *cent.** of Gomer's con-

* We are unable to state the corresponding dimensions in English; but believe that the piece in the text is much of the same description as our obsolete $4\frac{2}{5}$ inch.—T.

Digitized by Google

struction; of a compound of 92 parts copper, 5 pewter, 4 iron, and 4 antimony. Wishing also to try the result of iron and antimony by themselves with the copper, a similar mortar was cast composed of 92 parts copper, 4 iron, and 6 of antimony. These two experiments were even greater failures than the former. The 24 pounder burst in the proof; and the two mortars were not subjected to it, for fear that they would share the same fate.

64. Cast iron guns, tried at different periods, have always been rejected from artillery land service. They require a great thickness of metal, which renders the pieces heavy and difficult of transport: further, they do not afford the desirable security in the delivery of their fire.

Proofs, made at la Fère in 1821, upon cast iron Swedish and French guns, said very little in favor of this metal. Comparatively recent proofs have been made upon a large scale during the year 1838, upon guns cast in the best foundries of Sweden, England, and France. Although these proofs are not concluded, the results hitherto obtained show that the French foundries are no whit inferior to those of the other powers. They appear much more capable of resisting than were the guns cast in 1821, and we have been able to fire 1,200 rounds per gun with a charge of $\frac{1}{3}$ the weight of the shot; but such flaws have appeared as to show that we ought to abandon this description of ordnance.*

65. Attempts were also made at various periods to improve guns by forming the bore of a cast iron tube, which was kept steady in the mould by means of iron centres for the core: this

* As there may be non-military readers of the Artillery Records who may conceive that the opinions enunciated in the text above are currently held at the present day, we think it right to state that iron ordnance, so far from being at a discount, are becoming greater favorites every day. The author does not state in what time the 1,200 rounds were fired; but iron ordnance is perfectly capable, and much moreso than brass, of sustaining as continued a fire as any Artillerist wants. To the iron 9 pounders reamed up to twelves, for the introduction of which into the service we are indebted to Major Anstruther, C. B., of the Madras Artillery, the British were mainly indebted for the victory of Soobraon, and we hope soon to see the reamed up and truncated twelves of the same Officer doing effective service as batteries of position.—T.

Digitized by Google

cylinder, plunged into the brass, uniting itself with the alloy, especially on the exterior surface. They enlarged the calibre of the gun, by removing a slight portion of the thickness of the iron. M. *le chef de bataillon* Ducros renewed these experiments at Strasburg in 1818, upon a twenty-four, and a four pounder; the bore of the first was incorrect in the centre, and the piece was not bored: the second succeeded, and the result was favourable enough in the proofs to which it was submitted at *la Fére* in 1821; but the great difficulty in forging from a single piece of iron a cylinder sufficiently long to form the bore of siege and garrison guns gave rise to the idea of substituting for it a shorter cylinder, to which the name of "Manchon" was given, which was equally made of forged iron, and which took up no more length than was required for the charge and a few centimetres in front of the shot. This *manchon* was kept steady by an iron core placed towards the centre of the piece. These guns, thus fabricated being indented by the shot (164*) precisely like those made of bronze, cast iron was substituted for forged, on account of its greater power of resistance, and the guns were thus with the bore complete, and part thereof cast. The union of the metal was quite perfect externally; but internally there was nothing beyond a strong adhesion. After a few rounds, the cast portion rent, and did not allow of a continuance of the fire without danger. In order to guard against the disruption of the cast portion, a thickness of bronze to the extent of some millimetres was subsequently left on the interior coating of the cylinder. This new method was equally unsuccessful—the cast portion rent just the same, and the guns showed flaws. The same process was applied to the *manchons* of forged iron, with the two-fold object of guarding against oxydation of the metal, and increasing the resistance offered to the pressure of the projectile. No better success attended this plan. The indentations of the shot occurred as in the previous cases, and, besides, there formed, at the expiration of a very short period many more *egrène-*

* The para. referred to, is not contained in the M.S., which is merely a few extracts from the article in the *Journal des Sciences*, Militaire.—T.

Digitized by Google

*ments**, and flaws then are usually exhibited, because the bronze, which coated the iron was in this case more deeply impregnated with pewter.

Finally, under the impression that the indentations caused by the shot might be attributed to the bad qualities which the iron acquired even in the fabrication of cylinders, the metal of which burns in consequence of the number of times that it is subjected to the action of heat, an attempt was made to form portions of the bore in sockets of iron or even of steel, united and firmly bound together by iron hoops. This process was even less successful than the *manchons* of a single piece. The hoops burst, and the sockets separated by the shock of the fire.

66. The little success which has followed the different attempts, which we have related, to prolong the durability of guns, appears to demonstrate that bronze is the most preferable alloy to employ.

Of Bronze.

58. Pewter can be amalgamated with copper in any proportion, and forms with this metal compositions differing greatly in their color, their hardness, their tenacity, and the uses for which they are employed. In general it requires but a very small quantity of pewter to diminish in a remarkable manner the ductility and the tenacity of the metals, with which it is united, and to render them considerably harder. This remark is especially applicable to copper, with which it forms the alloy known under the designation of bronze. We shall only examine its properties under the character of gun metal. For a considerable period, the name of gun metal has been given to a fixed proportion of 11 parts in weight of pewter to 100 of copper, or 111 of alloy. The combination is carried on, on a large scale, in reverberating furnaces; but, in this case, it must be observed that, the pewter being much more fusible and oxydable than the copper, if these two metals were to be put into

* We have no corresponding term that I am aware of for this. It means the melting of the tin and separating from the other portions of the metal.—T.

Digitized by Google

the furnace at the same time, the first would be in a state of fusion long before the other, and oxydization would proceed to a great extent; part of the pewter would be thus lost in scoriæ, and the remainder would enter into the alloy. It is necessary therefore to melt the copper first, and subsequently project the pewter in suitable proportions into the bath. It is necessary also to stir the liquid materials repeatedly and carefully, to prevent the pewter, which is specifically lighter, rising to the surface, and with a view to the greater homogeneity of the compound.

The metal, resulting from this mixture, is of a yellowish hue, or golden, according to the quality of copper employed, and its degree of purity; it presents the following peculiarities.

More sonorous than the component metals, this quality is augmented by allowing it to cool gradually. It is harder than either of them taken separately. More fusible than copper, and less so than pewter, it melts at 1,800° of the centigrade. It is less oxydable and especially less ductile than either of the metals employed: less tenacious than copper, and more so than pewter: more malleable in its natural state; but it becomes still more so, when, after having been heated, it is suddenly plunged into cold water. The alteration is very sensible in a thin sheet of it. The tempering then produces upon the bronze, as well as upon copper an exactly opposite effect to that which steel experiences under the same circumstances It is of a greater density than the medium of the two constituent parts, which proves the penetration of one into the other. This density is 870. Lastly, it breaks almost without noise, and presents generally a tolerably coarse grain, facetwise, by no means uniform, and studded with spots of pewter. These different characteristics of the fracture, with the exception of that which relates to the noise, are very variable, and are to be attributed to the fusion, the effect of which is more decided in proportion as the cooling of the metal has been more gradual, which may arise from the circumstance of the volume of the object melted being greater, or the temperature being

Digitized by Google

more elevated, we can easily account for the liquation by the difference of the specific gravity of the two metals which compose the bronze, and by that of their fusibility: the first of these causes acts as long as the alloy is perfectly liquid and the second, when the heat is too feeble to prevent the copper from congealing, is yet sufficiently powerful to hold the pewter in a state of fusion. A complete separation of the two metals would ensue without their reciprocal affinity; but as that is not sufficiently powerful to neutralize altogether the affinity peculiar to the pewter, it cannot oppose the flying off of the disengaged portion of this metal, which is attracted then to the parts of the mass, which the caloric has kept longer in a state of fusion, and these give rise to an augmentation of its characteristics. Hence it is that in a mass of bronze, such as a gun, differing in thickness throughout its length, the successive deposits, both horizontal and vertical, differ among themselves by the quantity of pewter diffused through them; that is to say, in their character. The parts which solidify last; or, in other terms, those which remain hot the longest, are always those which contain an excess of pewter.

The hardness of the bronze increases, and its ductility decreases, in proportion as the quantity of pewter is increased. This augmentation, however, must have its limits; for a great quantity of pewter, and a small portion of copper gives a compound just as malleable, as a great quantity of copper, and a small one of pewter. From a proportion equal to eight or ten of copper to one of pewter, and *vice versâ*, a brittle alloy is obtained, but beyond these two limits the brittleness very sensibly diminishes. The fusibility of the bronze increases with the quantity of pewter. It is probable that both the copper and the pewter are refined by successive meltings, and thus free themselves from more oxydable metals which render them impure. The hardness of the bronze will thus increase, when the metals, of which it is compounded, shall have been re-cast several times, for the purity of the alloy exerts a powerful in-

Digitized by Google

fluence over its hardness. We have already remarked (see pewter*) upon that of lead and arsenic.

The action of the bronze upon oxygen gas and atmospheric air appears to remain the same, whatever its peculiar character may be.

As to the density, it goes on increasing up to 25 or 30 per cent. of alloy, the limit at which it appears to attain its maximum, it then goes on decreasing in proportion as the quantity of pewter increases, but to a much greater degree. We should remark, further, that the specific gravity is greater in proportion as the temperature of the bath has been raised, and the solidification been slower.

In the state of fusion, the absorbed pewter tends in preference to remain in its combination with the copper during the cooling down of the mass, and it is consequently the disengaged copper, which in the beginning yields to liquefaction, and then carries the other along with it, which renders this liquefaction more considerable. Iron and zinc, in the proportions of some thousand parts, do not alter the qualities of the bronze; they increase its homogeneity, as also its hardness, just as an equal quantity of pewter would have done. They also anticipate the liquation of it; but 0·02 of iron makes a very irregular distribution of it, which is manifested by deep and numerous hissing sounds. Even lead in small proportions greatly diminishes the resistance of the bronze, and it ought to be carefully avoided. Antimony hardens the copper, but it yet more destroys its ductility, and the alloy is inferior to bronze.

Charge: Resistance of the Atmosphere.

139. It has been thought that the recoil diminished the velocity of the shot: repeated experiments have demonstrated the contrary; neither the weight of the piece, nor the greater nor less degree of recoil has any influence upon the velocity.

157. Experience has shown that after some hundred rounds,

* This extract is not in the M.S.

Digitized by Google

the vents made of common gun metal generally run, so that the pieces can no longer be served. Several attempts have been made to remedy this—small chambers have been contrived at the bottom of the bore; the metal of the vent field has been raised, &c.; but none of these methods have succeeded. Afterwards the plan was tried of composing the vent either of iron, or of copper. Amongst all the methods employed of fitting a vent of a metal different from that of the piece, that which has been looked on as the best consists in screwing in a vent of bolt copper. Consequently when a gun is cast now-a-days, a very large vent is pierced, and the interior of it formed into a female screw, and a copper cylinder, or male screw, is screwed into it. In the centre of this is pierced the real vent.* When this is considerably enlarged, and we desire to replace it, a large hole is bored afresh in it, so that the copper in which the original vent was drilled may be entirely withdrawn. The female screw is then again tapped, and the new vent inserted. Pieces of large calibre can be thus bouched three times,† each of these vents will stand from 1,500 to 2,000 rounds slow firing, and about 1,000 quick firing without enlarging. Hence it follows that a piece may fire from 3,000 to 6,000 rounds, without our troubling ourselves about the vent. The heating and the length of the piece greatly contribute to injuring the vent.

If we neglect to put copper vents to our new guns, we shall find ourselves in a sad predicament in a campaign. This happened to the Hanoverian Artillery in 1793, after the battle of Famurs. The vents of guns of 6 and 18 calibres in length were so enlarged after firing from 250 to 300 rounds with 3 lbs. of powder that the pieces could no longer be served. Fortunately they had time to adapt copper vents to them. At the siege of Valenciennes the vents of the battering guns were so injured that three machines were in constant use at the latter

* In the Madras service, it is usual to drill the vent before the bolt is screwed in. This ensures the vent being in the centre of the bolt.—T.

† There is no limit as to the number of times a gun will stand bouching. By punching a square hole in the head of the old vent for a purchase, and screwing it carefully out the female screw in the gun is uninjured, and consequently, not requiring fresh tapping, no enlargement takes place.—T.

Digitized by Google

end of it in replacing the vents. It takes a whole day to *bouche* a heavy gun.*

Windage.

166. It would appear that the importance of limitation of windage has been overlooked, and that this point has not received the attention which it deserves. The great difference of windage in the different artillery services is an evident proof that in this respect every thing has been decided arbitrarily, and without examination into the nature of the thing. It is strange that in every artillery service, the amount of the windage has been regulated by the size of the shot thrown. Why should the 24 pounder have double the windage of the 3 pounder. Are the inevitable defects in casting shot twice as great in the former of these cases as in the latter? What experiments have been made on this point? Or is it less important to fire accurately with a 24 pounder than with a three? If any difference should exist, it is the siege pieces which ought to have the least windage, because they fire against embrasures; that is to say, against small objects, which are not so easy to hit as masses of troops.†

169. It would be impossible to suppose that the pieces would suffer more by a diminution of the windage. In fact, it is by a blow of the shot, (a bound, as it were at the place where it is rammed home in front of the charge) and consequently by an excess of windage, that the shot begins to make indentations; and there is reason to believe that this greatness of windage contributes to the more rapid deterioration of the piece.

173. The author conceives that it is a great defect in siege and battering pieces when the difference of metal exceeds half a degree. In fact, in firing during a siege against the enemy's

* It can be done by the method in the preceding note in about three or four hours.—T.

† The author is evidently quite abroad on the subject, it is hardly necessary to explain even to the non-professional reader that red hot shot are thrown from siege guns, but never from field pieces. The former therefore require an allowance to be made for the expansion of the shot, which the latter do not.—T.

Digitized by Google

embrasures at a distance of from 300 to 600 paces, we cannot make use of the line of metal range at one degree elevation, as the guns would carry too high.

On the Tangent Scale.

176. The shape of tangent scales has varied considerably. Experience has shown that all tangent scales, which are not attached to the piece and which are carried by the man who lays it, or in the small store box, are rarely used on field service, and not always even with siege and garrison pieces.

177. There is not the slightest difficulty in adapting a tangent scale of a convenient shape to any gun whatever, new or old, a hole, following a line perpendicular to the axis of the piece is bored in the thickness of the breech. A graduated cylinder* is introduced into it, having inches and tenths marked on one side of it, and degrees on the other: this cylinder has a head which can be laid hold of in order to raise it. A screw, which enters the breech horizontally fixes the cylinder, after it has been raised to the required degree of elevation. This construction is at once so useful and so simple that we are struck with astonishment how any others, which are not at all adapted to the object in view, could ever have been thought of. But thus it is with all inventions.

Two Letters from an Old Campaigner, extracted from the Bombay Times.

My attention has been directed to an extract from the *Naval and Military Gazette*, dated the 8th April, which appeared in your paper of the 10th June, commenting on an article in the last *Quarterly Review* on our Military establishments, and condemning the horse artillery service. I am of a different opinion to others who appear to think the writer in the *Quarterly* evidently well conversant with his subject, and differ with the writer in his opinions as to the advisabi-

* A half cylinder in the Madras service.—T.

Digitized by Google

lity of turning foot artillery batteries into horse artillery, I will endeavour as concisely as the subject will admit to lay down my reasons and objections.

I shall base my arguments on this sound principle—" let every army be efficient;" and no army can be efficient without each arm composing that army being efficient in itself. Each arm of the service must perform its own part, and therefore, on this principle, foot artillery cannot be horse artillery—infantry cannot be dragoons.

The writer says he is, " among those who entertain no sectarian predilections that the *kernel* of the army ought to be its artillery." I fear he does entertain some such sectarian ideas. There is no doubt, I think, that the *kernel* of the army is, and must ever be, the infantry. Who does not remember the impenetrable squares at Waterloo, which the French cavalry galloped round and round, but could find no corner to enter at? These squares were indeed hard *shells*, whilst the poor artillerymen were the *kernel*, for they were compelled to abandon their guns and take shelter in the infantry squares. So much for the *kernel*.

The writer next says:—" We have partially noticed the " recommendation of the writer (in the *Quarterly*, to do away " with the horse artillery, &c.," and talks about the cost of Horse Artillery. Now if expense be his only object, it would be a much greater saving to do away with the Life Guards and a few of those corps that never go beyond London and Windsor.

He further says:—" This pet section of the corps is the " ruin of the rest of the artillery." The most sensible answer to this is, what is the commandant of artillery about to allow the whole regiment to be ruined for the sake of the horse artillery?

Again he says:—" People seem to think from the chariot pacing they see on Woolwich Common, and in Phœnix Park, &c., the horse artillery in action are employed in galloping with cavalry from one part of the field to another;" and

Digitized by Google

then asks "if they did this at Waterloo or Quartrebras? When cavalry are put to speed, it is when they charge, at the very moment when they need the service of the horse artillery for other purposes than keeping up with them." What is meant by other purposes, I cannot say, but horse artillery should be kept in reserve with the cavalry, for it is at these very charges they can be brought into full force. They should accompany every charge when practicable, and pour a round of grape into the enemy directly the cavalry clear their front; and I will venture to say the royal horse artillery will keep up with any cavalry at any pace.

Again he says:—"The only thing on which horse artillery pique themselves is superior speed—and proceeds," Let us soberly examine this crotchet. Let the guns, for instance, be nine-pounders. Here we see guns and limbers with identical ammunition and stores, &c.; with two gunners on each limber; consequently the teams have the same to carry. Can we imagine any preponderance of speed here on the part of the horse artillery? None.

But the waggons, says the advocates of the horse artillery: Remember that the waggons of the field battery are extra laden each with six men of their respective gun detachments, without whose presence the guns cannot be served, while the horse artillery, having all their men mounted in detachment, are hussar gunners! and so on; and urges that horse artillery waggons might possibly beat the foot artillery waggons by a length or two, whilst the guns would be neck and neck. So much for pretension as to speed." But I say, I want no waggons: the field of action is not the place for your magazines, which undoubtedly your ammunition waggons are. Leave your waggons under cover, then try your speed. The above is all capital on Woolwich Common or in Phœnix Park, but let us extend our views a little beyond Woolwich, and then examine this field battery as compared with horse artillery on the detachment system. Suppose a mountainous country, or a valley intersected with

Digitized by Google

deep ravines, rivers, and watercourses—all serious obstacles to artillery: now suppose we had to deal here with an enemy, what immense delay would inevitably occur in dragging some thirty and forty ammunition waggons across, or getting them up a steep hill; and this very delay gives the enemy time to frustrate all the General's plans, whereas a troop on the detachment system, would be up in a crack and off again at a gallop.

The foot artillery may say we can leave our waggons behind: yes, so you can, but then all your men must walk, and so must your horses, for five men are not enough to work a 9 pounder; and for a gun to be badly worked in action, it had better stay out altogether.

Again, and the greatest objection of all, is taking the ammunition waggons into action, which must be done with field batteries, for the men to work the guns come from the waggons. The more carriages, the more liability to accidents of all kinds. Suppose the waggons upset or stick fast in a nullah or *wet ditch* (which has been known,) how is the gun to be worked?—and the waggons may be blown up, as was the case at Gwalior. All these are accidents artillery are liable to, and therefore the skilful artillerist will endeavour to avoid them, I may therefore safely say that to avoid all these, is to make your gun independent of its cumbersome waggon; and the detachment system does do this: the gun and its detachment are as compact, complete and serviceable, as anything can be, and a troop can be drawn up on as small a space as any infantry square, but I'll defy a foot artillery field battery, with its limbering ammunition waggons, to get into the same space. And then, as I said before, what is the chance they are not all blown up: and remember, not only waggons and ammunition go but horses and men as well.

The writer now cleverly shows how foot artillerymen are to be turned into horse artillery in a *day*: he says—"But if the field batteries are to be armed with twelve pounders, let them be constructed on the same principle as to windage and

Digitized by Google

disposition of metal, as the light nine pounders, with which the horse artillery are now being armed, and the *bugbear* about speed must vanish. As to the plea that horse artillery having gun detachments at hand, &c. need not take their waggons into action, we have only to say, let the off horses of field batteries be provided with saddles on which to mount their gun detachments when any movement of celerity is required, and the field batteries need not take their waggons into action."

A more absurd proposition I never heard of. The three off horses can only carry three men, with two limber men, giving five men to work a nine pounder, instead of nine men, the proper complement. This proposition must also have been intended for Woolwich Common, where they fire blank cartridge and have a billiard table to gallop over; but to send a nine pounder into action with only five men to work it, I should say was madness. What would Sir Charles Napier say to this? Then what are the chances that some of your men are not knocked over: your guns being isolated from all assistance of their waggons, what is to be done? Let the writer answer this.

But suppose, in attempting this grand feat, they suddenly come upon a deep ravine or any other obstacle: what means has a gun with only five men to work it to get over these obstacles? Why none. These are only a few of the objections against turning foot artillery into horse artillery, but I think quite sufficient to show the utter helplessness they would be thrown into.

Again he says—" This, as we have said on former occasions, is the way, (yes, to ruin the service) and the only way in which the Bengal horse artillery are organized, and they have for weeks together in that hot climate been known to accompany cavalry in marches of unprecedented length; and as to speed, this horse artillery, not on the royal horse artillery system of mounted detachments, is capable with their six pounders of passing over a measured half mile and delivering

Digitized by Google

a round of case in one minute and fifteen seconds,—a feat which we question whether the Queen's horse artillery ever surpassed."

What a pity the writer stopped at one half mile, because this is no trial: why did he not advance for two or three half miles, and fire two rounds at each, and then ask the same question? The writer is very unfortunate in his selection of the Bengal horse artillery, because it is a known fact, that a troop of Bombay horse artillery (which is exactly on the same detachment system as the Queen's,) was placed alongside of a Bengal troop of horse artillery at Cabool in 1839, and four distances marked out: they advanced and fired two rounds at each distance,—the Bombay troop beating the Bengal hollow. The writer quotes the Bengal horse artillery as having made marches of unprecedented length. Yes, they marched to Cabool, with the assistance of H. M. 13th Light Infantry; but not an infantry man ever laid hands upon a Bombay gun, either horse or foot! Again he says:—"If celerity of movement is required, (and quotes the royal horse artillery as the only way,) mount the gun detachments on the off horses, and leave the waggon behind." He forgets, or does not know, that the off horses of the Bengal horse artillery are always mounted; yet still they require their off waggon drivers, and cannot go into action without their waggons: and this is the very system the writer advocates for field batteries mounting their off horses and leaving their waggons behind. But probably as the writer can turn a foot artilleryman into a horse artilleryman in a *day*, he has also some other wonderful means of carrying his remaining four detachment men in the air unseen, in which case he would leave his waggons behind.

The writer again says—"The details of drill in a troop, &c. are so little at variance with a battery, that a field battery might be turned into a troop in a day."

Prodigious! This is the most wonderful stride in modern tactics I have lately heard of—it beats railroads all to nothing.

Digitized by Google

A foot soldier to be taught to ride in a day! As far as working a gun, they must be the same, but a horse artilleryman must not only be taught to ride, which takes months, but also to drive; he must be most active in mounting and dismounting. All this takes a considerable time. The off horses should never on any account be mounted: the reason is obvious—their draught is already heavy enough without extra weight: the gun cannot move till it is limbered up, and then, instead of moving off at once, as it would do on the detachment system, has to wait some minutes for the off horses to be mounted. If the off horses are mounted, how is all the marching kit to be carried? The Bombay horse artillery and dragoons are independent of any one. The whole of the horses' kit,—heel ropes, head stalls, and comb and brush, watering bridle and nose bag,—are all carried on the horses: they arrive at their ground, and the Europeans picket their own horses in five minutes; but not so in Bengal, for I believe the syces carry the heel ropes or chains. The Madras horse artillery is on the same detachment system as at Bombay. I once saw a troop, and a neater troop I never beheld; they had brown leather harness, which looked particularly well: they gave me a field day, and every thing was in fine order. I mention this circumstance to show that I am not a prejudiced man to any particular presidency.

The writer throughout evinces a strong desire to abolish horse artillery,—in other words, to turn foot artillery field batteries into horse artillery, for the sake of saving expense and preventing the ruin of the regiment; but whilst he is recommending all this change, he loses sight of his object, and is caught in his own net. First, he recommends *extra saddles, horse artillery horses, equipment, &c., &c.*, the same as the horse artillery, to be supplied to all the foot artillery field batteries, so that were all his suggestions to be attended to, the batteries would soon become as expensive as the horse artillery, without their efficiency, for in no one way has he proved that his guns, when any movement of celerity is re-

Digitized by Google

quired, can get into action without his waggons; and it must be allowed that the field of action is no place for your magazine, which your ammunition waggons are. But he mentions the Bengal horse artillery as the only system to mount your off horses, and then leave your waggons behind. The Bengal horse artillery, as I have stated before, always have their off horses mounted; yet with all this they are obliged to take their waggons into action. Gwalior perhaps may not be forgotten, where all the waggons and limbers were blown up.

The great beauty of the field batteries on their present system of organization is, that whilst they are most efficient their cost is trifling, and I doubt very much if they cost one Rupee more than the old bullock system. I have no doubt myself in the end they will be a saving to government, if an eye is kept on the price of the horse, for I know from experience, first rate horses may be bought for 300 Rupees for field batteries.

But horse and foot artillery are indispensable. Horse artillery may be made very great use of: they can act with the skirmishers of cavalry, cover all deployments,—in fact there is no position where horse artillery cannot be brought into play. Foot artillery batteries should keep their proper place with the infantry, and they are invaluable; but they must ever be cumbersome till they get rid of their waggons. I for one disapprove of mounting the men; it gives extra draught to the horses, and obliges you to take your waggons under fire. Now both these ought to be avoided, and if you require to pack your force in a small space, it would not only be most dangerous, but impossible with so many carriages. A four horse battery in column of route takes up 177 yards—77 yards more than a troop on the detachment system with six horses in a gun. No field batteries, or even horse artillery, on the system advocated by the writer, can for a moment compete in celerity with a troop on the detachment system; and to prove it I'll instance one movement.

Digitized by Google

The one has twelve carriages, the other only its six guns: these are both ordered to a distant part of the field in column of sub-divisions or route. Half of the battery with twelve carriages would of course be standing still, when the troop with its six guns and detachments would be on the move at a gallop. The same reasoning holds good on coming into action.

A battery of six guns and waggons occupies 225 yards, consequently a troop without waggons occupies half that distance.

Such a system as the writer in the *Quarterly* proposes, would be to destroy your artillery. I am of opinion every gun should be independent of its waggon: the proper complement of men to work a gun should be with the gun, and not with the waggon, and lastly no ammunition waggon should be allowed under fire, for to take them into action is opposed to all reason, to all judgment, and to all generalship.

AN OLD CAMPAIGNER.

In my last letter I confined my remarks chiefly to the necessity and superiority of horse artillery over foot artillery field batteries, condemning in toto the system of taking your ammunition waggons into action. Since that, I have given the subject my earnest consideration, and am still more convinced of the absolute necessity of every gun being entirely independent of its waggon. I dont mean to say by this that the ammunition waggons are to be out of reach altogether; certainly not—they should be placed under cover, safe from the possibility of the enemy's fire touching them. I touched but slightly in my last on the real duties of horse artillery in the field, and, as it will prove profitable I hope to many, I will endeavour to point out what, in my opinion, those duties are, but let it be remembered, that I only talk of horse artillery on the detachment system. As I stated in my former letter, so I state again—horse artillery should be kept in reserve with the cavalry, unless it should so appear that no opportunity will be likely to offer for either the cavalry or

Digitized by Google

horse artillery acting; but this would seldom occur—but, should it be so, the horse artillery can of course then be made use of with the infantry. Horse artillery on the detachment system has this great superiority over all artillery, whether horse or foot, not on the detachment system, viz., extricating themselves from all difficulties, and, in conjunction with cavalry, of producing the most brilliant results: it is the combination of these two arms on the field of action that most undoubtedly will very often decide the day. Cavalry, generally acting on the offensive, should as I stated in my former remarks, always be accompanied, when practicable, with horse artillery, for horse artillery add considerably to the strength of cavalry, and if their fire does not entirely break the foe, it must be allowed it shakes and causes death and confusion in the enemy's ranks, and adds considerably to success. After victory, cavalry are employed in pursuing the enemy. Horse artillery should accompany them. Cavalry are employed in covering a retreat, whether in consequence of a defeat or otherwise. Horse artillery should invariably be employed on this important duty, and perhaps one of the most important duties they have to perform, because it will require great tact and skill in keeping the pursuing enemy from pressing too closely on the retreating columns. Here let me ask, of what use it would be a dozen lumbering ammunition waggons galloping about? They would not only be an embarrassment to their own guns but a very great impediment to the cavalry. Horse artillery should accompany all cavalry expeditions whose object may be to surprise the enemy, whether by attacking its rear, flanks, or drawing off his attention by false attacks, or of cutting off convoys of provisions and stores: in all these duties the greatest secrecy and judgment is necessary—no high road should be followed, some circuitous and not thought of route should be taken, by which the enemy would least suspect his adversary's approach, and therefore be the least protected or prepared for an attack. What a nuisance on expeditions like these would a dozen ammunition waggons be, and very likely pros-

Digitized by Google

trate the whole scheme—a gun and its detachment can go any where, but not a waggon. The body of a waggon is the most unwieldy thing ever man laid his hands on when unlimbered. Then leaving the waggons behind, and mounting the off horses in a field battery, and two limber men, how would these guns get over all the difficulties they might have to encounter, with only five men to work them? Why in this way—by losing perhaps half the day, and tiring the cavalry to death by protecting their guns, and very likely have to dismount and work at the guns also. The commander of an army may wish to obtain possession before the enemy of some particular post, village, or bridge across a river, at a distance of some fifteen or twenty miles: his first idea would be to push on some cavalry and horse artillery;—this exploit in front of an enemy might prove a very dangerous duty, and in effecting it endanger the loss of the guns. Would it not then be madness to send waggons also, and endanger their loss as well: and how would guns, with only five men to work them, undertake such a dangerous expedition? I think the above duties clearly prove the great advantages of horse artillery over foot artillery field batteries, when properly made use of, and the very great embarrassment and impediment ammunition waggons on the field of action, or even a common parade, must be to all the other branches of the service, manœuvring with guns, for it will scarcely be believed by the uninitiated, that two and even three infantry battalions in square could stand on the same ground as six ammunition waggons in close battery would occupy. In a proper combination of horse artillery with cavalry great judgment and skill is necessary: it is not a brigade parade that will teach it;—he must be well versed with the actual capabilities of artillery, the effect of fire, the best range, the best missile, and, lastly, the most advantageous position to cause the greatest effect with the least loss of life. These may appear trifles, but they are very important trifles, and therefore none should ever command artillery but the artillery officers themselves. It is a general rule

Digitized by Google

that when the two arms are acting together the one conforms to the other, and vise versâ; and this depends on whichever may be the attacking column, as the attacking column is the one to be conformed to. I have endeavoured, as far as a few remarks like these will allow, to show what the actual duties of horse artillery in the field are, and chiefly to prove the utter absurdity of turning foot artillery into horse artillery in a day, or in a century. It would be, and always is, a most amusing sight to see a Jack Tar on horseback; for he is as great a clog to the horse as the horse is to him—ergo, a foot soldier on horseback—and such would be the proportion of seventy or eighty ammunition waggons to the cavalry and infantry on the field of action, or a common parade. I can't say what the "Iron Duke's" opinion may be regarding the horse artillery, but Napoleon so often expressed his opinion of them, and made such use of them, and especially with his cavalry, that he considered his cavalry inefficient without horse artillery, because they are a mutual support. As I perceive another writer on the same subject spring up at Woolwich, I would suggest to him the propriety of a practical demonstration instead of a theoretical one. They have horse artillery and field batteries both at Woolwich; take out a troop and its detachment, and a field battery without its waggons: mount the three off horses and the limber with two men. Here then you have six guns turned into horse artillery in a day, and equal to compete with any horse artillery. Mark out, now, three miles across country, having three or four ravines or good large ditches, a hill to ascend and descend, and to attack the enemy in the rear. In this attack we will suppose every gun engaged loses two men, they are ordered to retreat, and have perhaps one or two slight skirmishes, say with about forty infantry soldiers, who try to cut them off. I shall not offer an opinion as to which will be the best able to defend themselves in retreating—the horse artillery with sixty mounted good troopers or the foot artillery guns with three men! It is a great mistake attaching horse artillery to infantry brigades—

Digitized by Google

the reasons must be sufficiently obvious. Horse artillery should always be attached to cavalry brigades and divisions, for nothing sooner gives a horse a sore back than crawling along the road with infantry.

N. B.—Since writing the above, I have been obligingly favoured with the following extracts from a friend, which completely bear out my opinion—they are extracts from a French work.

"All military men, who have any experience of war, are aware that horse, or flying artillery, are principally designed to act in consort with cavalry."

"Napoleon, who for such a length of time calculated the respective strengths of the different arms, says, in his memoirs, 'the horse artillery is the complement of the cavalry arm.'"*

Speech of Lieutenant General Sir Howard Douglas, Bart, M. P., on "Ordnance Estimates," in the House of Commons; Friday, June 27th, 1845.

Sir H. Douglas entreated the Committee not to be led away by the Honorable Member's regard for pecuniary economy, to interfere with this splendid and efficient corps—the horse artillery. The Honorable Member said it might be dispensed with in peace, and speedily reconstituted for war. This is not so. No corps of this description and scientific character can be suddenly formed. Nothing in our artillery system has contributed more to the success and renown of our arms, than that power of concentration, celerity of movement; and active combination of artillery with the other arms, which attended the introduction of horse artillery. The efficiency of the horse artillery is the result of many years of improvement and experience. He (Sir H. Douglas) would not attempt to take up the time of the Committee to trace this. For this, it would

* Bombay Times, August 19th, and September 23d, 1848.

Digitized by Google

be necessary to go back to the time of Frederick the Great, who introduced horse artillery in that war, in which, by celerity of movement, he defeated, with the same army, enemies on every frontier of his states. He might show the prodigious advantages reaped in all the armies of Europe from the adoption of this arm—the important uses made of it by Dumourier, Pichegrue, and Napoleon; and in our own service, the brilliant services of that corps in the Peninsular war. He (Sir H. Douglas) would not attempt to specify the many brilliant proofs, exhibited in that war of the peculiar advantages of that description of artillery to which the Honorable Member's observations relate; but with the permission of the Committee would refer only to the battle of the Nivelle on the 10th of November, 1813.

Clauzel was strongly posted on a ridge, having the village of Sarre in front, covered by two formidable redoubts, San Barbe and Grenada. He thought the country in front was so difficult and impracticable for artillery, that he was astonished when eighteen British guns opened upon those redoubts at daylight in the morning. Under the powerful effect of a shower of shot poured upon S. Barbe the Infantry of the fourth division stormed and carried that redoubt. Ross (the present Sir Hew) then galloped—he (Sir H. Douglas) begged the Committee to mark the term—galloped to a rising ground in rear of the other redoubt, Grenada, drove the enemy from it, when the British infantry carried it, and the village of Sarre, and advanced to the attack of Clauzel's main position. Part of it was carried; but Clauzel stood firm, covered by another redoubt and a powerful battery. These were speedily silenced by Ross's troop of horse artillery, the only battery that had been able to surmount the difficulties of the ground after passing Sarre. The British Infantry then carried the redoubt, drove Clauzel from his position, forced the French to retire, and the rout was complete. Sir, that operation was worth all the money the horse artillery has ever cost the country. He (Sir H. Douglas) cordially concurred in the vote for increas-

Digitized by Google

ing the number of men of the foot artillery; far from thinking it unnecessary, it is indispensable; but it is totally inadequate to the wants of the service. He rejoiced to find in these estimates, additional votes for improving the coast defences, for ordnance stores and for armament; but he begged the Committee to remember that, however liberally the material of the coast defences may be provided for, however promptly these may be completed, you will have done little towards the security of the country, unless you are prepared to man those defences with a sufficient number of well trained and efficient artillerymen, ready, at any time, for any sudden emergency. To be prepared for, is, not to provoke, but to prevent war. The most perilous part of a war to this country, would be the commencement, before you get your strength together, and can put forth your force for meeting menace, with active defence, as Britons ought, to keep war from the shores of England. But you have not at present one artillery man per gun for existing defences: you have not a sufficient number of artillerymen to keep up the foreign reliefs properly with well trained men. You have not a piece of ordnance, nor an artilleryman in all the Colonies of the Pacific.

Such are the demands on the head quarter establishment, the practical school of artillery, that artillerymen, and even Non-commissioned Officers are frequently sent away imperfectly trained, and often without any instruction in the gun practice. Remember it is not only necessary to retain practical proficiency in the management of the arms which triumphed in the late war, but to become as proficient and as superior in acquiring a perfect knowledge, an expert and effectual management of the new arms which will be generally used, together with a gigantic power, in future wars. Improvements in naval and military ordnance keep pace with the gigantic progress making in other departments of mechanical and practical science. The arms of the late war have been superseded—more powerful engines—more ponderous bolts are forged. Such now is the state of naval artillery and gunnery,

Digitized by Google

and the means of aggression, that coast defences require additional strength, corresponding armament, and, above all, efficient management, to prevent the approach of forces, which, if permitted to close, are now, as has been shown in a recent instance, more formidable than ever to coast batteries. He (Sir H. Douglas) would repeat then, in the strongest possible terms, that whatever else we may do, we do nothing effectually, towards the security of the country, against any sudden attack, if we provide not in time the means to man our batteries with a sufficient number of well instructed, efficient artillerymen.*

Newton's Improvements in Wheels.

The present invention is stated to consist of a peculiar method of casting iron wheels for locomotive engines and railway carriages, and to have for its object the uniform cooling of the various parts of the casting, and thereby to avoid fracture from irregular chilling.

The Patentee observes, that soon after the advantages of iron wheels with chilled peripheries and flanches were established, the difficulty of casting them in one piece was ascertained. The rim was found to cool sooner than those parts which connect it to the "hub" (commonly called nave,) and then to shrink in cooling, and either break, or become so weakened as to break, on being subjected to a strain or jar. Various methods of overcoming this difficulty have been suggested,—such as the employment of a "slit hub" formed of segments, bound together by iron hoops, and bending the arms or spokes, to allow of their shrinking.

The form of the connecting parts of the wheel which the Patentee prefers is that of a simple disc; and his mode of chilling the rim, flanche, and connecting parts, consists in employing a mould of metal, instead of sand, as heretofore,

* Extracted from Hansard's Parliamentary Debates.

Digitized by Google

so that the metallic surfaces of the mould shall come in contact with the surfaces of the casting.

In practice it has been found necessary to chill only one surface of the disc; and in that case, the top portion of the metal is replaced by one in sand, made in the usual manner.*

Materiality of the Electric Fluid.

Mr. Lake of the Royal Laboratory, Portsmouth, has communicated to the *Lancet* the results of a singular experiment, which appears to show that the electric agent is really fluid; and that when collected so as not to exert its powers of attraction and repulsion, it obeys the laws of gravitation like carbonic acid and other gases. The electric fluid was received in a leaden jar insulated on a glass plate. At the lower part of the jar was a crack in the side, of a star-like form, and from around this the metallic coating was removed. On charging the jar, it was observed that the electric fluid soon began to flow out in a stream from the lower opening; and on continuing the working of the machine, it flowed over the lip of the jar, descending in a faint luminous conical stream (visible only in the dark) until it reached the level of the outside coating, over which it became gradually diffused, forming as it were, a frill, or collar. When the jar was a little inclined on one side, there was a perceptible difference in the time of its escape over the higher and lower parts of the lip, from the latter of which it began to flow first. On discontinuing the working of the machine, the fluid first ceased to flow at the lip of the jar, and then at the lower aperture. On renewing the operation, it first re-appeared at the lower aperture, and afterwards at the mouth. This very ingenious experiment appears to establish the fact, that the electric fluid is material, and is influenced, under certain circumstances, by the laws of gravitation.†

* Mechanics' Magazine, January, 1848.
† Mechanics' Magazine, April, 1848.

Digitized by Google

Ordnance for the Royal Navy.

(*Extract from the Naval and Military Gazette, No.* 767.)

The Board of Admiralty have recently, in conjunction with the Board of Ordnance, ordered that the following guns shall in future be used in her Majesty's Navy, such having been found, after repeated experiments, to be the least liable to objection, on account of their facility of working, minimum recoil, and other qualities. The particular description of gun to be used on board any steamer or ship of war will depend upon the capabilities of the vessel herself:—

	cwt.	*feet.*	*inch.*	
10 inch Gun of	87	9	4	General Millar's.
Do.	84	9	4	do. modified.
8 inch	65	9	0	do.
Do.	60	8	10	do.
Do.	52	8	0	do.
68 Pounder	95	10	0	Lieutenant Colonel Dundas'.
56 do.	98	11	0	Mr. Monk's.
56 do.	87	10	0	do.
42 do.	84	10	0	Lieutenant Colonel Dundas'.
42 do.	75	10	0	do.
42 do.	67	9	6	do.
32 do.	56	9	6	Bloomfield's.
32 do.	50	9	0	Monk's new Gun.
32 do. 50 and	48	8	0	Sir A. Dickson's and Genl. Millar's.
32 do.	45	8	6	Monk's new Gun.
32 do.	42	8	0	do.
32 do.	41	8	0	Bloomfield's.
32 do.	40	7	6	Congreve's.
32 do.	39	7	6	Bloomfield's.
32 do.	32	6	6	do.
32 do.	25	6	0	do.
32 do.	25	6	0	Lieutenant Colonel Dundas'.
32 do.	25	5	4	Sir A. Dickson's.
18 do.	22	7	0	Bloomfield's.

Digitized by Google

	cwt.	feet.	inch.	
18 Pounder	20	6	0	Bloomfield's.
18 do.	15	5	6	do.
42 do. Carronade	22	4	6	General Melville's.
32 do. do.	17	4	0	do.
24 do. do.	13	3	9	do.
18 do. do.	10	3	4	do.
12 do. do.	6	2	8	do.
6 do. do.	4¾	2	9	Bloomfield's.
Mortars 13 inch	101	4	5	do.
Do. 10 do.	52	3	9	do.
How. 24 Pdr. Brass	13	4	8½	Millar's.
Do. 12 do.	10	4	7	Dundas'.
Do. do.	6½	3	9¼	Millar's.
Brass Gun 6 Pdr.	6	5	0	Bloomfield's.

"The number of men required to work these guns varies from three and one boy for the smallest, to 18 and one boy for the heaviest."—"*Hampshire Telegraph.*"

Memorandum No. 219, from Colonel James Ketchen, Brigadier Commandant of Artillery, to the Secretary to the Military Board, Fort Saint George, dated Saint Thomas' Mount, 6th May 1848.

The undersigned has the honor with reference to the Military Board's letter, dated 19th March 1847,* calling for a concise report of the trials and experiments made with the view of ascertaining the relative qualities of Europe, and Country Linseed Oil to state that,

* No. 129.

1. The following experiments have been carried on by the Director of the Artillery Depôt, with three descriptions of paint mixed with linseed oil as marginally indicated.

No. 1. Europe boiled linseed oil as received from the Presidency Arsenal.

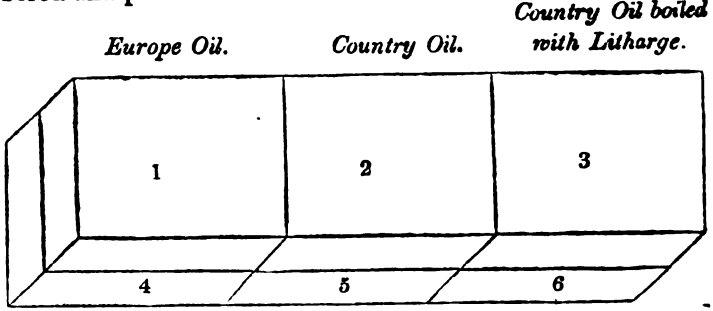
No. 2. Country oil as received from the Commissariat Department.

No. 3. Same as No. 2, but boiled for 5 hours with 7 ozs. of red litharge gradually added to it during the time of boiling.

2. On the 6th May 1847, a plank of well seasoned Teakwood, 4 inches thick, and 6 feet long, was sawn

Digitized by Google

down the centre forming two planks of two inches thickness each. Each plank was marked into three divisions and numbered and painted thus:



One of the planks marked 1, 2 and 3 was exposed to all weathers and the other marked 4, 5 and 6 kept under cover.

3. The planks received the first coat of paint on the 6th May 1847.

Nos. 1 and 4 dried in 24 hours.
„ 2 and 5 „ „ 2½ days.
„ 3 and 6 „ „ 3 „

4. On the 2d July 1847, they were examined, when Nos. 1 and 4 were found to be the best in appearance of the three specimens.

Europe Oil.

Nos. 3 and 6 have not preserved so good an appearance as Nos. 1 and 4, but better than 2 and 5; the plank that had been exposed was somewhat blistered.

Country Oil with Litharge.

Nos. 2 and 5 peeled off when scratched with the finger nail.

Country raw Oil.

5. The plank marked 1, 2 and 3 that had been exposed to the weather had become a light slate color, which adhered to the finger when rubbed; no difference was perceptible in the plank which had been kept under cover.

6. On the 5th July 1847, a second coat of paint was given to each plank, and a second examination took place on the 1st September 1847.

Digitized by Google

Europe Oil. Nos. 1 and 4 were again found to have the best appearance.

Country Oil with Litharge. Nos. 3 and 6 stand next, but are not to be compared with the Europe Oil; No. 6 is sticky, and peels off when rubbed hard with the finger.

Country raw Oil. Nos. 2 and 5 are not so good as either of the others, No. 2 having lost its color, and its surface is covered with small blisters. No. 5 peeled off easily when rubbed with the finger.

7. The next process that these planks were subjected to, was, each board being washed, and well rubbed with cuttle fish, until quite smooth, and re-painted as before with two coats on the 3d and 6th September 1847.

The plank marked 1, 2, and 3, was then exposed to the weather, and that marked 4, 5, and 6, kept under cover until the 1st November 1847, when on an examination;

No. 1 was better than 2 and 3, the latter had lost their color, and were spotted with white.

No. 4 looked as well as when first painted, Nos. 5 and 6 were very sticky, particularly during wet weather, and peeled off when rubbed with the finger.

8. The next examination took place on the 3d January 1848, after the plank marked 1, 2 and 3 had been exposed to the weather, the whole of the last heavy monsoon; several white spots appeared on various parts of the plank, and the color of the whole had much faded; when rubbed hard, the paint came off like powder, but No. 1 retained its color better than Nos. 2 and 3.

Nos. 4, 5 and 6 became sticky during the rains, but 4 was less so than the two others.

9. Since January last the plank marked 1, 2, and 3, has been exposed to the weather, and upon a careful examination presents no perceptible difference in any of the three divisions, the whole appears to have suffered alike by the exposure.

Digitized by Google

10. The plank marked 4, 5, and 6, presents little difference in appearance, No. 4 has the best color and it cannot be rubbed off by the finger, Nos. 5 and 6 peel off when rubbed hard, but all three specimens are smooth, and of nearly an uniform appearance; and, on a reference to persons unacquainted with the various qualities of the linseed oils, used with the paint, much variety of opinion exists, as to which of the three was superior in appearance, but No. 4 has certainly, upon the whole, retained its color better than either of the other specimens.

11. The plank 1, 2, 3, was rubbed with a cloth by hand, the friction was regulated equally to the three specimens, and, as will be seen, the effect was the same.

12. The planks alluded to are herewith forwarded for the inspection of the Military Board.

Memorandum No. 215, from Colonel James Ketchen, Brigadier Commandant of Artillery, to the Secretary to the Military Board, Fort Saint George, dated Saint Thomas' Mount, 3d May, 1848.

With reference to a letter from the Military Board, dated 22d October, 1847, No. 1759, forwarding four specimens of the "Gutta Percha" as per margin,* and directing that they might be exposed to the direct natural action of solar heat, in order to ascertain whether they were applicable to Ordnance or other military purposes, the undersigned has the honor to state:

* 1 intended for harness traces.
2 „ for timber, for furniture, &c.
13 intended for tiling.
14 „ in substitution of tarpaulin.

2. That on the 1st January last each of the specimens received was divided into two equal parts; since that time one portion has been kept in the model room at the Artillery Depôt, and the other exposed to the action of the sun every day from 8 A. M. until 4 P. M. (Sundays excepted.)

3. The specimens marked 1, 13, and 14, have during the

Digitized by Google

exposure gradually decayed until they have become in the present perished state, as will appear upon an examination of the portions forwarded herewith. No. 2 does not appear to have been altered by the exposure, except in color which is much darker than it was.

4. During the hottest part of the day, No. 1 and 13 adhered to the wooden trough in which they were exposed, and became quite soft.

5. The undersigned has no hesitation in stating that he considers the specimens of Gutta Percha, above reported on, totally inapplicable to Ordnance purposes.

Memoirs translated from the new Work of General Paixham's, entitled "Constitution Militaire de la France." By Lieutenant Colonel Brereton, C. B. and K. H., Royal Horse Artillery. Communicated by Major C. C. Young, Royal Artillery.

The questions to be found in these treatises are of great importance to the armies of the whole civilized world, for the complete solution of one of them, which has now been discovered, will undoubtedly lead to a complete change in the art of war in general. But this solution is to the Artillery of the Line of still deeper importance, for its very existence is threatened by the fact that the new French musket has been rendered *superior* to field Artillery, and which ceases to be, as hitherto, the most powerful arm of battles; but I know the science and buoyant zeal of the British Artillery, I am confident it will not passively suffer this *abdication*, and I am also confident that, when the facts contained in these Memoirs shall have been known and appreciated, the Royal Artillery will 'ere long discover the secret and antidote hitherto sought in vain. This is, but in a small degree, perhaps, a question of science; like the self-acting safety valve, it may possibly suggest itself to the least gifted amongst us. Yet, whoever may be that fortunate discoverer, he will have the glory of rescuing his corps from the degradation which

Digitized by Google

now threatens it. With this object, I think it desirable to circulate these important papers; they state plainly the existing danger; and, which is better, give the *results* of the several experiments made during a long course of years to discover the secret which has hitherto eluded research. Yet these results are of the utmost value, for a great *principle*, in the law of projectiles, has thereby certainly been found, and, in our search after the great discovery, even the failures will be as beacons to avoid them.

(Signed) Wm. Brereton, Lieut. Colonel,
Royal Horse Artillery.

Woolwich, 6th May, 1850.

No. 1. Upon the New Musket of France.

It is a general supposition that a great advantage would be, to be able to fire, in the same space of time, a greater number of rounds; and the supposition is true, were the number of rounds only concerned, but it is less so of shots fired without aim, and in warfare such is the difficulty of transport that the power of expending ammunition exceeds that of the means of conveyance, therefore the constant anxiety of persons in command is to check the amount of firing, rather than to increase it. Improvement then is not required as to an increase of the number of shots fired, but that they may be so with more correctness and at a greater distance; this in fact is what has now happened for musket firing (already much improved since the peace), it has been supplanted by the fire of the Carbine Musket, which goes far beyond all reasonable expectation.

This is not the place in which to describe either this new arm, or the experiments by which skilful Officers have arrived at so great an improvement, but this is the result.

1stly. At a distance of 200 metres, against an object of two metres high, and two in width, this is, against a group of two or three men, an ordinary musket struck 44 times out of

Digitized by Google

100 rounds; with the new musket every ball of the 100 rounds struck the object.

2ndly. Against the same object, at the distance of 600 metres, the ordinary musket could not strike in 100 rounds, a field piece struck only 6 times; the new musket twenty-five times.

3dly. Against the same object, placed at a distance of 1,000 metres, or a fourth of a league, a distance at which the field piece deviated from six to eight metres from the point fired at, the new musket struck six times out of the 100 rounds; and even at that enormous distance, a marksman selected and, against a small object, hit it three times out of four shots. Thus art did here more than nature, for the best sight only can distinguish the point at a 1,000 metres distant which this musket could accurately strike; and add to this that the new carbine musket is not difficult of loading as is the old musket, and the recoil is less violent, and, what is very important, that the common arm now in use may be converted into the new one.

Napoleon has said that the musket is the best warlike machine invented by man; what would he have said, if he had seen the new arm? What will be the consequences of this change, it becomes of importance to examine. At 600 metres, the enemy's case shot will scarcely range, and his round shot will only hit a group of two or three men six times out of a hundred rounds, but at that distance our Infantry can make every shot tell upon the vast group of men and horses in action with a gun; the enemy's Artillery must soon be silenced; the same may happen to our Artillery from the enemy's musketry. Thus, on both sides, if a battery of Artillery be placed in line, and in advance, and if a company of Light Infantry be placed in front of it, there will probably be a complete extinction of fire of Artillery. No doubt the cannon will always retain its superiority in penetrating deeply into the heads of columns, in clearing obstacles, and in acting at considerable distances; but the fire of Light Infantry will

Digitized by Google

have a terrible effect against Field Batteries, and a swarm of Light Infantry upon the whole line, firing with such exactness, what will not be its effect upon an enemy's troops, upon its masses, and upon its officers, who will be selected as objects by the most practised of the marksmen? The operations, then, of Light Infantry will become the most important ones; but this change will be in nowise unfavourable to France which has invented the new arm; on the contrary, it will be beneficial to her, because no country has, in an equal degree, soldiers full of intelligence, of bravery, easy of acquiring instruction, and so adapted to the venturesome warfare of combatants entrusted to act upon their own conceptions.

But there is a still higher consideration with the ancient arms, which possessed neither a great range nor great correctness; the combatants engaged man to man, and the soldiers well disciplined, they for whom war was an art, had a decided advantage over soldiers less skilful. With fire arms, which strike from a distance, personal conflicts became less frequent, and the Infantry soldier, the gunner, were able to render service without being quite so perfectly instructed; but now that the musket has been rendered capable of striking a group of two or three men six times out of a 100 rounds, at a distance of a quarter of a league, and that at 200 metres distant every shot takes effect, it is evident that constant firing, and more especially the meeting of line against line, column against column, will become less frequent; that a change will take place in battles, and in manœuvres, and that in defence against an invasion, every national guard, however little varied a country may be, is enabled, under many circumstances, to render the same service as a disciplined soldier.

Doubtless, the more effectual an arm has been rendered, the more skilful should be the man who is to use it. Assuredly, with the new musket, it is desirable not only to have special corps for its use, but also to have in every corps well

Digitized by Google

selected marksmen, and kept a long time in the service. But in defending the country, when an enemy shall pass a defile, and we occupy the heights, when an enemy shall be on one side of a river and we upon the other, when an enemy shall advance upon our territory, and the people shall rise in his rear, against his convoys, upon his resources, against all his communications, is it not evident that then a peasant may fight without coming nearer than a quarter of a league (every one is brave at a distance), and thus the defenders of the country will be increased tenfold? All the danger will be thus in future for the aggressors who shall advance; hereafter every invasion will find a powerful resistance from the people defending themselves, and conquerors will be under the necessity of carrying into war more troops than it would be possible to set in motion. Thus, this new arm, a French invention, will not only be favourable to France, but also to all defence against attack, it will be in favour of the weak against the powerful, favourable to independence, to the rights, to the peace and the dearest interests of every nation, which is in fact the nature of real improvement.

No. 2. Upon a new Musket which has been constructed, and upon a new Cannon which has yet to be constructed.

It is easier now to describe the great precision and greater range of the new musket, than it was to give to it these qualities; but it will be useful to give this description, as it may be the best, perhaps the only means which may lead to the perfection of the cannon, as the musket has now been perfected. We will examine then the elements which have been combined in order to give so great an improvement to the musket; let us inquire how far each of these elements have aided in the success obtained, and this labor will be a commencement of that which may lead to the same result as respects the Artillery gun.

Rifled carbines had been long celebrated for precision; since the peace, continual experiments have been made in

Digitized by Google

France with this arm; it was found that although these rifles did give precision, they gave no increase of range, but, on the contrary, a diminution; it was then investigated what should be the number of threads, what their curvature and their form, and what would be the proper cartridge for this rifle. With all these objects, experiments on a great scale were made by the troops, and also during the war in Algeria, these experiments, together with the researches on the subject by Messrs. de Ponteharra and Thiery, and other officers, have thrown much light upon a question which it had not previously. The researches were also highly aided by a happy idea of M. Delvigne. Before that suggestion, the bullet had to be driven into the rifle by blows of the mallet, thereby rendering the firing very difficult and very slow; M. Delvigne showed, in 1828, how the bullet could be made to enter easily into the piece, and to quit it in a forced state. This conduced in a great measure to its present success, and thence firing, until then difficult, became as rapid as ordinary firing. M. Delvigne's method required a chamber at the bottom of the rifle; this chamber, however, was not free from difficulty and inconvenience. M. Thouvenin proposed to substitute for the chamber a stem of iron within the axis, which in stopping the ball, struck it so that the lead was made to penetrate the threads. This stem, which could be adjusted to the common musket, a great advantage, took its place amongst the elements which have been tried. Very recently, one of the officers who have most contributed to the success of the new musket, M. Mignet, showed that the stem could be dispensed with by means of a very simple contrivance, (by whom invented I am not aware). The first experiments proved that, in doing away with the stem, so far from diminishing the range and precision, both were increased; hence, with the exception of some difficulties which probably will be surmounted, simplicity and much diminution of expense have been obtained. The stem of M. Thouvenin, by facilitating the experiments has, however, contributed to the suc-

Digitized by Google

cess gained; these experiments without the stem would perhaps have been less simple and less conclusive.

Another and very important element of success, was the elongated and cylindro-conical form of bullet. The elongation of a projectile has this advantage that, in an equal mass, a smaller surface is exposed to the resistance of the air, and that a projectile may be driven with equal force by a fire arm of less calibre. This idea is not a new one, it is even of long standing, for in 1770, M. Turpin tried it at La Fére and at Metz; it was tried in the years 2, 6, and 9, (Revolution,) by M. Guiton de Morveau, with a cylinder of cast iron with a leaden ring; it was proposed by M. Bodeau in 1800; in 1815 it was tried in Russia with an elipsodiacal projectile; the English Colonel Millar experimented with the cylindro-conical form; experiments were made successfully at Charleville by Colonel Carron of the French Artillery in 1823; Captain Blois proposed the important suggestion of hollowing the projectile at the end, in order to send forward the centre of gravity; after these proposals came those of Messieurs Thiery, Delvigne, and others. Finally, during the year 1844, and subsequently, Messieurs Tamisier, Migne, and Thouvenin, worked experiments which were very complete; they together combined the different elements of the question, and carried on their labors with great perseverance. The Duc de Montpensier, who commanded at Vincennes, gave them a co-operation which was equally scientific and cordial, and by his support prevented the delays and obstacles by which the commencement of every improvement is for the most part fettered. Amongst the new elements introduced were the circular grooves which M. Tamisier placed in rear of the cylinder of the projectile; these grooves oppose to the air's resistance, surfaces perpendicular to the direction, and, by an eventual resistance of the air conveniently provided for, the ball, when from any cause it has a tendency to alter its direction, is made to resume its intended one. These grooves are to the projectile what the shaft is to the ja-

Digitized by Google

velin, feathers to the arrow, the tail to the rocket; and here I may be suffered to observe that in this a considerable application has been made of the principle which, in 1823, caused the success of my shell guns, a principle which consists in obtaining the amount of required action, and in overcoming the resistance of the air by increase of the the mass and diminution of the velocity. Accordingly the old ball weighed only from 25 to 26 grammes, the new one weighs 48; the charge of powder for the old ball was 9 grammes, that for the new one is only 4½; that is to say, that, like what was done in the case of my guns, the projectile weighs almost double, and the charge of powder is reduced to one half. Such have been the principal elements of the success obtained; and moreover that the ordinary musket may be converted into a carbine musket, which is an important consideration in the practical introduction of this improvement. And here let us record an observation which may add further to what has been gained; it is, that it is much better to bring up the arm to the aim from below than from above, the firing is much more correct, and the reason is a palpable one; experience has proved its truth in Belgium, also in England, and the English have lately used this method on a great scale in their Indian war.

No doubt there will be some difficulties as to details, and some objections, more or less well founded, against the general adoption of this new arm. But what are details in a question which affects a change in warfare, and which change, as has been shown, will favor the superiority of France, defence over attacks, and which is for the best interests of humanity.

The foregoing facts, as respects the new musket, having been stated, let us now see what is the fact, and what can be done as regards Artillery, in order that this service may not remain powerless and stationary behind advancement, a position to which assuredly it will not willingly consign itself.

Digitized by Google

Many of the elements which we have enumerated may be in common with cannon and the ordinary musket, the form of the projectile, the great mass in lieu of the great velocity, &c.; but the projectile of cast iron cannot enter into the threads except by means of appendages or weak bolts; but the forcing cannot be effected to a projectile of cast iron as of one of lead; but the friction in the threads being caused by a mass 200 and 300 times heavier than a musket ball may destroy all, but, &c. &c. It is then indispensable that, by some equivalent methods, what cannot be exactly copied may be substituted, and here is opened a vast field beset with obstacles. I am but imperfectly acquainted with what has been attempted for this object in different parts of Europe, but here are some facts upon this question.

Long since, in 1742, Robins pointed out that it would be very advantageous to have pieces of Artillery rifled spirally like carbines; this improvement, he said, would effect a great revolution in warfare. In 1844, when the success of the carbine musket was certain, I was directed to endeavor to obtain a similar result for guns of Artillery. I worked at this object; the 30th of July I delivered in my first report, and on the 27th December I gave in another upon the trials to be made. In 1845, according to some other proposals as well as mine, experiments were made at Vincennes with 6 pounder balls of different shapes; inconveniences were found, and neither precision nor increased range were obtained. In the same year the Marine Department granted me an experiment, from which I sought a certain result, which result was not obtained.

About this time and, I believe, even before it, experiments were made in Sweden, after the plans of a Piedmontese officer, M. Cavalli, and the result of these experiments was an increase of ranges over the ordinary ones of one-seventh, and even of one-third.

The Marine also made some experiments for M. Delvigne (to whom is due one of the principal causes of the success of

Digitized by Google

the new musket.) It was considered by the Marine that the results of the experiments were not satisfactory.

During the present year some new trials of M. Delvigne were exhibited; of these trials (amongst which is the application of an ingenious idea) one was by means of projectiles of lead which does not solve the general question as to pieces of Artillery. The other was upon projectiles in cast iron, those supplied with moveable appendages have been a failure; there were already different kinds of these tried in the experiments at Versailles, mentioned above.

The newspapers, and probably some memoirs of private individuals, have proposed different methods more or less worthy of consideration. Finally, the question is still agitated, but the solution and the probable means by which to arrive at it are still to be sought; yet this solution must be possible, seeing that in Sweden it has been partially obtained.

That it is possible, is clear from a close attention to, and consideration of, existing facts; it is possible, if, in place of giving theories for solution, we restrict ourselves (which is a hundred times preferable) to *seek* for the cannon what has been *sought* for the musket. But it is necessary to seek logically, simply, and with perseverance. I am certain of the possibility, if we can surmount, by practical methods, simple in their nature, the difficulties presented by the cannon, and which the musket did not present; and this discovery is not alone possible, it is absolutely indispensable, unless it be intended that the Artillery shall be put down by Light Infantry; and if the Artillery desire, instead of remaining in the back-ground, to make a progress in advance, which will give to it, on the one hand, guns rapid in manœuvre, and, on the other, guns more formidable as to precision and length of range.

In this as in every thing, in order to obtain useful and honorable success, three things must be combined, KNOWLEDGE, the WILL, and the POWER.

Digitized by Google

No. 3. On the Means of Preventing the Deviation of Spherical Projectiles.

Robins, Euler, Lombard, and other *savans*, have, without solving it, treated of the questions of the deviations which are caused in the flight of the spherical projectile, by the distance more or less observable between its centre of gravity and the centre of its figure. They have not agreed amongst themselves, and their opinions have been so far from a solution of the question, that the Commission of the year 1803 interpret them in one sense, whilst M. Poisson, in his Memoirs of 1838, gives a different one, and sometimes opposes those opinions; Hutton, in his experiments at Woolwich in 1796, remarked that a certain position of the projectile diminishes the deviations, but the English Artillery had kept that remark a secret; subsequently it endeavoured to derive advantage from it, and particularly in the practice of shrapnell shells; but the advantages derived by these means were not such as to cause attention.

In the year 1803, the report of the French experiments declared that "*shells with bottoms have a greater range than shells without bottoms*," and again stated that "*shells with bottoms deviated no more than shells without bottoms*," adding, however, these words, "an effect for which no reason can be given;" and in the voluminous work which was then printed, these different effects are spoken of, surprise is expressed, and they are variously explained; but, as a principle, it is laid down that the main cause is the vibrations within the piece.

However, one important matter was then perceived (I am not aware that it was so for the first time), and M. Clement says that the irregularity of firing, as regards length of ranges, must be referred to the same cause which produces irregularities to the right or to the left; and in his work published in 1808, the same officer, after studying the experiments of 1803, says at page 43: "The flight of a shell becomes

Digitized by Google

longer and more regular, the greater the distance of its centre of gravity is from the centre of its figure." Every one thought at the time that this was a paradox; nevertheless, it was true.

But M. Clement did not define what should be the respective position of the two centres in the fire arm, and his principle, without a knowledge of that position would give, as will be seen hereafter, in the greater number of his experiments, results altogether different from those he expected to have obtained. In 1813, the English communicated Hutton's secret to the Prussians, who then had but little leisure to study the use of it, but subsequently they made some experiments and succeeded in a method by which the lateral deviations were diminished; they marked the shells with three red circles, so as to be enabled to place them in short howitzers in the described position. In 1826 and 1827, considerable experiments were made at Mayence, some of the effects of the eccentricity were tried and kept secret; but it would appear that only erroneous principles as to theory were established, and but little was done for practice. In 1828, some Austrian and Saxon Officers having witnessed the Prussian experiments, guessed the secret. In 1830, the Prussians imparted it to the Emperor of Russia, by whom experiments were ordered, and the Academecian M. Ostrogratski was directed to study this question. In 1835, the method reached Belgium, experiments were conducted there with great skill and nicety. In 1837, a Prussian Officer having brought the system (still however limited to lateral deviations) to France, some trials were made at Vincennes. In 1839, that Officer published in Belgium the results; but neither the report made in France of the trials at Vincennes, nor the pamphlet published in Belgium, lead to the belief that the means had been established, or that the true conditions of it were known, particularly as regards the range. In 1838, amongst ourselves we were so little agreed as to the causes of deviation, and of the *method* of avoiding them, that M. Poisson, Inspector of

Digitized by Google

Artillery, *savans* of the highest order, in his very elaborate Memoirs, thus expresses himself: "The equations of the movements of a projectile are too complicated to be possibly able to deduce their approximate values from their unknown ones, sufficiently simple to be of any utility;" and he was forced to consider deviations, or their causes, to be very inconsiderable; yet, in practice, and particularly in hollow projectiles, they are often very great, and as to the distance between the centre of gravity, and the centre of the figure, his theory did not ascribe to the distance any considerable influence, yet, practically, that influence, as will be hereafter seen, is a very decided one. Finally, he gave nothing which materially advanced the theory, and nothing of which practice might avail itself.

Such are the historical facts, let us now see the Ballistic facts; the latter I will take at the moment when they have some value from the experiments made in Belgium. The results of these experiments (passing over useless details) were as follows, taking the mediums:

1stly. When the centre of gravity was above, the range was greater than when it was below, in the proportion of 2,467 to 1,315.

2ndly. When the centre of gravity was to the right or to the left, the shots went always to the right or to the left.

These experiments took place in Belgium between 1835 and 1840, with different calibres. With a howitzer gun of the calibre of 150 (throwing the shell of Om, 27, horizontally), the distance being 1,000 metres, by the *method* adverted to, the two first rounds exactly struck the centre of the target, and all the others at points very near to it.

These results appearing to me to be worthy of attention, in 1841 I asked and obtained permission to make some experiments at Metz, at the Polytechnic School there; the following are the principal results obtained by those experiments: A 12 pounder field gun, with its charge, its shot and common

Digitized by Google

bottom, at an angle of 4 degrees; again, with the same charge, the same bottom, and the same angle, but with a shot having an eccentric hollowing, so as to separate the centre of gravity from the centre of the figure, and which weighed 5 kilogrammes instead of 6; when the centre of gravity was placed on the right, the shots always went to the right; when the centre of gravity was placed on the left, the shots went always to the left; when the centre of gravity was placed at the bottom, the ranges were always short; when the centre of gravity was placed at the top, the ranges were always long; and the measures of the advantages obtained were as follows: The medium range which, by the ordinary shot was 1,500 metres, was by the new method 1,900 metres, the increase was 400 metres. The mean deviations in the ordinary shot were 13 hundredths of the range, by the method they were only 8 hundredths, and the difference of range between the longest and the shortest, by the ordinary firing, was 276 hundredths, whilst by the method it was only 153 hundredths.

Here then assuredly were considerable improvements, both as to the correctness and length of range, and moreover a diminution of one-sixth of the weight of the projectile, which will considerably lighten the ammunition waggons. Similar results were obtained during these experiments, with the shell of Om, 15, whether with the small or great charge; and it may be seen in the tables of practice that, for example, with a charge of one kilogramme, and always at an angle of 4 degrees, firing in the ordinary manner, that the medium range was 1,166 metres, whilst by the *method* it was 1,605 metres, giving an increase of 439 metres; and the superiority of precision, as regards lateral deviations, was very great, for, by the ordinary firing, the medium deviation was 16 thousandths of the range, but by the *method* was only 2 thousandths, an almost mathematical precision. I must, however, acknowledge that, from some inexpressible anomaly in the precision of the rounds, as regards the equality of the ranges, the shots

Digitized by Google

from this howitzer and this charge, were more reciprocally equal without the *method.*

It may now be established, that the experiments conducted in England and in Germany having produced remarkable results, those results having been much improved by the experiments in Belgium and these latter being confirmed by those made at Metz. There is in the distance of the centre of gravity, from the centre of the figure of spherical projectiles a condition, which formerly was the cause of deviation and of difference of range, and which condition may become the means of obtaining precision and uniformity of ranges, long or short, at pleasure. The *theory* of deviation, difficult, arduous, and incomprehensible, as it has been, even for the *savans*, is rendered by these experiments simple, and perfectly demonstrated, and particularly, if not in all cases, at least in those of projectiles fired with care, advantages may be derived from these results, which may be most valuable. This Memoir was presented in 1841, but my proposal that attention should be given to the subject was not accepted. The following year I obtained from the Marine Department a trial of my howitzer gun of 80, and an experiment was made, the result of which was, that, at an angle of 10 degrees, with

a charge of 6 kilogrammes the range was -	2,342	metres.
with the same charge with the *method* -	2,923	„
with a charge of 8 kilogrammes and the *method*	3,236	„

Here then with the same charge, by the effect of the *method* only, the range was increased nearly 600 metres, and an increase of 894 metres by merely adding a little to the charge.

More recently, having obtained from the Marine Department in 1844, a trial of a gun without a chamber of the calibre 120, of the weight necessary for firing solid as well as hollow shot, this trial (which was successful) gave as the re-

Digitized by Google

sult, in reference to the question of the two centres and of the *method*, as follows: (charge 9 kilogrammes, angle 10 degrees):

Range of solid shot, - - -	2,422 metres.
Range of ordinary shell, - -	2,465 „
Range of shell with the *method*,	2,866 „

Here an addition of range was attained by employment of the *method* of 401 metres.

This *method* therefore, is worthy of attention, assuredly, if means be discovered by which Artillery may be enabled to fire projectiles which are not spherical, possessing the precision and greater range which have been obtained for the new musket (which question has been treated of in a former paper), the advantage to be obtained, by the *method* for the correction of the effect of the two centres will be exceeded, and that *method* will have only served for the purpose of throwing light upon the theory which, to the present time, has remained obscure.

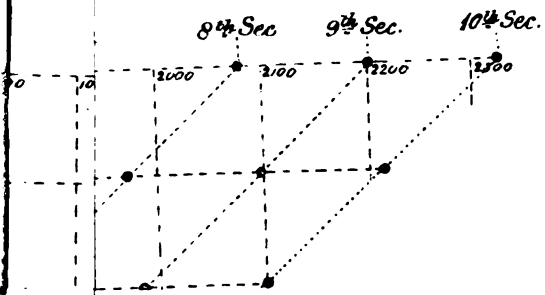
But so long as the Artillery, for want of better, is fixed to projectiles of a spherical form, I cannot understand why it should reject the employment of a *method* approved of by other nations, and which gives at once much greater lateral and longitudinal precision, and which, moreover, affords a certainty of obtaining with regularity the utmost extent of range.*

* Extracts from the Minutes of Proceedings of the Royal Artillery Institution.

Digitized by Google

s of ng the sit-
netes with each
Thro

all from
Edn, a largest
with time,
d of velocity.
ue, be



Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

INDEX FOR 1840.

MISCELLANEOUS.

	Commencing Page 1.	*Page.*
Artillery	..Mode of Landing.....	50
„	...Method of Mounting and Dismounting..	51
Balance Geometric	...Patent, by Dampier.....	40
Bangalore	...Ordnance, Carriages, Ammunition and Stores supplied from the Arsenal of, for the Kurnool Field Force.....	5
Bellary	...Proof of Gunpowder found at Kurnool,...	26
„	...Ordnance, Carriages, Ammunition and Stores supplied from Arsenal of, for Kurnool Field Force	5
Bombardiers	...of the Royal Artillery to rank as Corporals.....	40
British Army	...New Musket for.....	41
Canara	..Forests of, Experiments on Timber from,	31
Chinese Artillery	...State of.....	46
Draught	...Ordnance for, in the Field.....	32
„	... „ „ from Station to Station...	35
Egyptian Army	...Numerical strength in 1840.....	44
Eprouvette Pendulum	...Proof of Gunpowder from Kurnool with,	25
Fort Saint George	...Ordnance, Carriages, Ammunition and Stores supplied from for Kurnool Field Force.....	5
Fuzil	...Proof of Gunpowder from Kurnool with,	24
Galvanism	...Application of, by Mr. Roberts in blasting Rocks and detonating Gunpowder under water.....	62
Gunpowder	...Proof of, found in Kurnool in 1839.....	23
„	.. „ „ with Fuzil...	24
„	... „ „ Pendulum Eprouvette	25
„	...Appearance of different kinds found at Kurnool.....	25
Heat and Cold	...Table of Effects of.....	69
Kurnool, Fort of	...Ordnance found on the works of.....	17
„ Field Force	...List of, Ordnance, Carriages, Ammunition and Stores supplied from the Arsenals of Fort Saint George, Bangalore, Bellary and Secunderabad for use of.....	5
„ Fortress of	..Ordnance, and Stores &c. found in the,	17
Lock Percussion	...Trial of new.....	42
Musket New	...for the British Army.....	41
Oliver Cromwell	...Words of Command for priming, &c. in the time of	40

Digitized by Google

		Page.
Ordnance	...Found in the Fort of Kurnool in 1815.	1
"	...Statement of at the sieges of different places.....	3
"	...Found in the Fortress of Kurnool in 1839.....	17
"	...Supplied from different Arsenals for the use of the Kurnool Field Force...	5
"	...Abstract of, found in the Fortress of Kurnool.....	19
"	...Cattle for, Scale of for the Field.....	32
"	... " " from Station to Station	35
Roberts, Mr.	...mode of blasting rocks and detonating Gunpowder under water by the aid of Galvanism.....	62
Royal Artillery	...Bombardiers of, to rank as Corporals...	40
Secunderabad	...Ordnance, Carriages, Ammunition and Stores, supplied from the Arsenal of, for the Kurnool Field Force.....	5
Shot and shells	...Statement of Expenditure of, at different sieges, ...	4
Sieges	..Expenditure of shotand shells atdifferent	4
"	...Statement of Ordnance at different....	3
Small Arms	...Memorandum on the recently approved, for the British Army.....	61
Soldiers Arab,	..Description and Equipment of.....	42
Stores	...Memorandum regarding disposal of found at Kurnool.....	20
Thermometers	...reduction of different, to each others standard.....	53
"	...Table, shewing correspondence between different.....	59
Timber	...Teak, experiments with from Alleppy, Travancore, Ponany and Calicut.....	27
"	...different kinds, experiment on the strength of.....	29
"	...Experiments on from the Forests of Canara...	31
Weights and Measures	...Tables of.....	55

Digitized by Google

MISCELLANEOUS.

Commencing Page 63.

Page.

Actions Naval, loss in 180
Anstruther, Capt. proposal for increasing strength of Army 137
„ „ reply to remarks by Lieut. Ash.... 259
Army Indian &c—proposal by Capt. Anstruther for increasing the strength of the by changing all the guns from the 18 Pdrs. downwards into others of greater bore. 137
„ „ &c. remarks by Lieut. Ash on a proposal by Capt. P. Anstruther to increase the strength of the by changing all the guns from 18 Pdrs. downwards into others of greater bore &c. 158
Artillery Foot report of Capt. Coghlan on Swords for 191
„ Proper method of directing against boats advancing to the assault. 105
„ Equipments of, report of Capt. Coghlan on during the War in Affghanistan.. 183
Ash, Lieut. remarks on Captain Anstruther proposal.. 158
Association British, Extract from the proceedings of, with the orders of the Madras Government thereon 71

Bedamee Forts of, description of by Captain Burgoyne. 132
Boats proper method of directing Artillery against advancing to the assault 105
Bullocks, report of Captain Coghlan on 194

Camels, report of Captain Coghlan on 195
„ „ on by Captain Anderson 217
„ Battery expense of 227

Digitized by Google

Page.

Carriages Field, report of Captain Coghlan on 184
„ Store and Forge report of Capt. Coghlan on 189
„ Spare do. do. do..... 190
„ Iron Field proposed by the late Lieut. Col. W. H. Rochfort 97
„ Memorandum by Captain J. Sinclair Bombay Artillery on 103
Chuenpee Fort of, references to a plan of the attack on 91
Chusan, Extracts from the statistical notes on by Lieut. Ouchterlony, Madras Engineers 63
Coghlan, Captain report of on Military Equipments.. 183
Conductors metallic for powder magazines, extract from the Minutes of Consultation on 111
„ „ Experiments on by Dr.O'Shaughnessy 115
„ „ Powder Magazines professor Daniel 239
„ „ „ „ „ Farraday 248

Directors Court of, Extract of a Military letter from, on the subject of lightning Conductors to powder magazines 73
Draft, report of Capt.Coghlan on the best,for Field Guns 195

Eyes Pintail, report of Captain Coghlan on 187

Fire-arms, report of Captain Coghlan on, for Troops and Companies 191

Guards Flank, mode of arranging and posting 129
Guns Hand, description of 135

Horses report of Captain Coghlan on 191
„ for Foot Artillery do. do. do. 193

Digitized by Google

Page.

Nepanee Fort short description of the by Captain F. Burgoyne 93

Obstructions auxiliary to boats advancing to an assault 108
Ordnance return of captured at the Siege of Nepanee 94

Patrol, mode of conducting 129
Poles, report of Captain Coghlan on 188
Power animal, notes on, by Captain Anderson 218

Saul timber, experiments on 257
Shafts, report of Captain Coghlan on 188
Shaughnessy, W. B. O. Esq. copy of letter from, to Officiating Secretary Military Board on lightning Conductors. 74
„ Letter from, to the Secretary Military Board on lightning Conductors 114
Shot Spherical Case effect of Lieut. Col. H. Jones .. 109
Stores, Regulations to be observed relative to the receipt and examination of at the several Presidencies. 181
Stuart, Lieut. Col. J. Extract of a letter from forwarding copy of the reports from Professors Daniel and Farraday 72
„ „ Extract of a letter from, forwarding copy Professor Shaughnessy on lightning Conductors 113
„ „ Extract of a letter from on lightning Conductors 111
Swords report of Capt. Coghlan on for Foot Arty. ... 191

Teak, Pegue, and Moulmein, experiments on 257
Timber, experiments on strength of 257
Ty-cock-tou Fort of references to a plan of attack on the 91

Digitized by Google

Page.
Waggons ammunition report of, Captain Coghlan on 186
Wheels „ „ „ „ 187

Digitized by Google

Artillery proper method of directing, against Boats advancing to the assault — — — — — — 105.
" Equipments report of, during the war in Affghanistan, by Captain Coghlan Bombay Artillery — — 183.
Bedamee Forts, description of — — 132.
Chinese Forts, Plan of attack of — — 91.
Carriages Iron Field, proposed by the late Lt Colonel Rochfort in the Service of H. M. F. M. Donna Maria 2nd — 97.
Camel Battery — — — — — — 211.
Gun powder, samples of, found in the Arsenal of Chusan — — — 63.
" Mills Bombay explosion of — — 67.
Guards Flank, and Patrols — — 129.
Guns proposal for changing all from the 18 Pdr downwards into others of greater bore by Capt Anstruther Madras Artillery — — — — 137
Digitized by Google

Guns remarks on the above by Lt Ash
Bombay Artillery . . . . 158.
" alteration of, ordered by Capt. Anstruther
to the Remarks of Lt Ash Bombay Artly 259.
Magazines Powder, metallic conductors
recommended to be attached to &c . 64.
" metallic conductors for, regarding . 111.
" " sanctioned by C. D. 239.
Naval Actions, loss in . . . . 180.
Nesimmie Fort, in the Mahratta country
description of . . . . 93.
Shot-Spherical case, effect of at
Saint Sebastian . . . . 109.
Stores, regulations to be observed on receipt of,
from England under authority of C. D. 181.
Timber, experiments on the
strength of . . . . 257.

Digitized by Google

1842.

MISCELLANEOUS.

Commencing Page 265.

		Page.
Arms, Percussion	Ammunition for, Naval and Military	265
„ „	Lovells' suggestions for the care of	355
„ „	directions to be observed in using.	371
Carbine, Percussion	of the Cavalry	367
Carriage,	new pattern Indian Field, letter on by Captain Martin	275
„	new pattern, report on the defects of, by the Select Committee of Artillery Officers at Bombay	282
Draft	mode of attaching additional without increasiug the columns of Horse Artillery Guns	274
Gunpowder	of the Manufacture of at Madras Powder Mills, by Capt. Alcock	313
„	Manufacture of, at Ishapore	341
Guns, Dundas's & Monk's	experiments with at Woolwich	331
Gun Brass,	of the Ship "Royal George"	339
Gun, Monk's	bursting of, at Woolwich	353
„ large	made for Mehemit Ali	392
„ „	„ „ „ „ proof of...	354
„ Monk's	dimensions of	273
Jellalabad	notes on the defence of by Capt. Broadfoot	332
„	report of Major General Sale at ...	301
Ladders, scaling	construction and application of ..	289
Musket, Percussion	of the Regiment of Foot Guards...	365
Nizam's Artillery	reorganization of	328
Rifle, Percussion	of the Infantry	368
Rivers	singular manner of crossing	320
Rockets, Congreve	letter on, by Lieut. Col. Hessman	270
Shafts	with Light Field Carriages, letter on, by Capt. Hardy, Bombay Horse Artillery	269

Digitized by Google

Page.
Shot, Spherical Case substitution of, by Major Napier, Royal Artillery, at Waterloo ... 300
Shells, Percussion experiments with, at Woolwich ... 340

Digitized by Google

MISCELLANEOUS.

Commencing Page 389.

		Page.
Altitudes	Mode of measuring,.....	410
Artillery	Bombay, Drivers of, noticed for gallant conduct.....	406
„	Royal, History of.....	445
„	Employment of, in a Mountainous Country	449
„	Madras, Account of the formation of the..	461
„	Appointment of Benjamin Robins, Esq. as Engineer General and Commander in Chief of, ...	473
„	Madras, employed in China in 1840-41, and 42.—Extract from Medical Narrative of,.....	497
Banghy Parcels,	Petarrahs for,.....	482
Barometer,	Altitudes measured by.....	410
Battery	Camel, in Scinde.....	458
Bombay	Manufacture of Gunpowder at.....	389
Camels	Management of,.....	441
Camel	Battery in Scinde.....	458
Carriages	Indian Field, in Scinde.....	393
„	Light Field, Remarks on the Construction of, by Major Anstruther, C. B.....	489
Chain Shell	Improved—By Lieut. and Capt. H. Congreve	507
Chinese	Gunpowder.....	399
„	Artillery.....	400
„	Engineering.....	400
Dover	Mining Operations near	424
Drivers	Bombay Artillery Gallant conduct of,....	406
Egypt	Large guns for.....	392
Extract	from a Medical Narrative of the Madras Artillery employed in the Chinese war, 1840-41, and 42.....	497
French	Weights and Measures.....	409
Gunpowder	Manufacture of, at Bombay.....	389
„	Chinese, Proof of,.....	399
Gun	Single, Evil of detaching, on Service.....	397
Guns	Large, for Egypt.....	392

Digitized by Google

		Page.
Horse	Anatomy and Proportions of the	421
Horse Artillery	Bombay—1st Troop to be called Leslie's	405
Hydrabad	Battle of, in Scinde	416
India	Army of, Proposal for bestowing an acquisition of strength to, by Lieutenant and Captain H. Congreve	509
Indian	Field Carriages on Service	393
Leslie	Captain, Report by, on Indian Field Carriages	393
„	Major, 1st Troop Bombay Horse Artillery to be called Leslie's Troop for ever	405
Limber	for Pony draft, at Ningpo	395
Martello	Tower, new—by Lieut. & Capt H. Congreve	508
Measures	French, description of	409
Meeanee	Battle of, in Scinde	403
„	„ „ Correction in sketch of,	488
Mining	near Dover	424
Pony Draft,	Limber for, at Ningpo	395
Paint	Black the worst color for Woodwork	415
Petarrahs	for Banghy Parcels	482
Proposal	for bestowing an acquisition of strength to the Army of India—By Lt. & Capt. H. Congreve	509
Recoil	checked by relative position of weight	459
Remarks	on the construction of Light Field Carriages—By Major Anstruther	489
Robins, Benjn.	Esqr—Appointment of, as Engineer General and Commander-in-Chief of Artillery	473
Scinde	Battle of Meeanee, in,	403
„	„ „ Hyderabad, in	416
Service	Evil of detaching a single Gun on,	397
Shell	Improved chain—By Lt. & Captain H. Congreve	507
Steamer	War, by Stevens	401
Tower	Martello, new—By Lieut. & Capt. H. Congreve	508
War Steamer	by Stevens	401
Weights	French, description of,	409
Woodwork	Black the worst color for Paint for,	415
Yard	Standard English,	407

Digitized by Google

INDEX 1844.

MISCELLANEOUS.

Commencing at Page 513.

Page.

Batteries, Field. Bengal, Establishment and Allowance of:
- Company, European Foot Artillery, - - - - - 519
- „ Native „ „ - - - - - - 520
- Horse Field Battery, - - - - - - - - 521
- Field Battery, Elephant Draught, - - - - - 523
- Camel Battery, - - - - - - - - - 524
- Extra Batta when in the Field or Marching, - - - 522

Boats, Arming of, - - - - - - - - - 517

Lines, Native Infantry rendered capable of defence, - - - 513

Timber, Saul, method of seasoning in Bengal, - - - - 525

„ in the Tenasserim Provinces, - - - - - - 527

Digitized by Google

Digitized by Google

INDEX 1846.

MISCELLANEOUS.

Commencing at Page 532.

Page.

Armour, cumbrousness of, extract regarding the, - - - - 542
Bayonet, origin of, „ „ „ - - - - - 543
Cannons, materials of which they have been composed, - - 541
Fire Arms, origin of, - - - - - - - - - - 540
Gunpowder, quantities of, employed in various sieges, - - - 545
Percussion Caps, origin of, - - - - - - - - 544
Pistols, extract regarding, - - - - - - - - - 542
Qualification, test of, for direct appointments to the Corps of Artillery, - - - - - - - - - - - 532
Rot, Anti-dry, extract regarding, - - - - - - - - 561
Slings, extract regarding, - - - - - - - - 539
Swords, Damascus, - - - - - - - - - - 546
Timber, on seasoning, - - - - - - - - - 558
Trees, signs of increase, maturity and decay in, - - - - 548
Wood, on the preservation of, - - - - - - - - 550
„ Causes of the decay of, - - - - - - - - 554

Digitized by Google

Digitized by Google

INDEX FOR 1843.

Miscellaneous.

	Page.
Artillery, Horse or Flying, history of the introduction of, into Europe, -	640
,, ,, ,, description of - - - - - - -	645
Block, of Gyn fall, regarding the breaking of, when mounting a 56 Pounder Iron Gun, - - - - - - - - - - -	655
Caps, Percussion, statement showing the difference in the cost of, manufactured in England, Bengal, Bombay, and Madras, - -	655
Diakoptist, or War Engine, invented by Captain A. F. Oakes, - -	656
France, Artillery of - - - - - - - - - - -	660
,, Military Force of - - - - - - - - - -	658
Light Field Artillery of the French, - - - - - - - -	663
Teak-wood, note regarding - - - - - - - - - -	655

Digitized by Google

Digitized by Google

INDEX FOR 1849.

Miscellaneous.

	Page.
Artillery, Extracts from a treatise on, translated from the French, by Major P. J. Begbie, - - - - - - - -	682
Bowie Knife, and its inventor, - - - - - - - -	666
Casualties, comparative view of, in the modern Battles of India as compared with that of Waterloo, - - - -	667
Education, report on the state of, in the Polytechnic school at Paris, - - - - - - - - - - -	677
Electric Telegraph, on the induction of atmospheric electricity on the wires of the, by Professor J. Henry, - -	667
Lightning, trees most affected by, - - - - - -	666

Digitized by Google

Digitized by Google

INDEX FOR 1830.

Miscellaneous.

Page.

ELECTRIC FLUID, materiality of the, - - - - - - 710
HORSE ARTILLERY, two letters from an "old Campaigner" on, - 694
MUSKET, on the new *French*, - - - - - - - - - 717
Upon a new one *which has been constructed*, and upon a new *Cannon which has yet to be constructed*, - - 720
OIL LINSEED, Experiments with *Europe* and *Country*, - - 712
ORDNANCE ESTIMATES, speech of Genl. Sir H. Douglas, Bart. M. P. on, 706
ORDNANCE, for the Royal Navy, - - - - - - - 711
SPHERICAL PROJECTILES, means of preventing the deviation of, - 729
WHEELS, Newton's improvement in, - - - - - - 709

Digitized by Google



Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

ARTILLERY. 194 pages.

Smiths Gunner's Slide. P 81 et seq. & 86

ARTILLERY. 194 pages.

MACHINES. 112 pages.

PYROTECHNY. 50 pages.

KARKHANAS. 62 pages.

FORMS 42 pages.

LABORATORY. 71 pages.

Digitized by Google